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TERRAIN BACKSCATTERING COEFFICIENT
GENERATOR

THESIS

Ricardo Mediavilla, Second Lieutenant, USAF
AFIT/GE/ENG/99M-18

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TERRAIN BACKSCATTERING COEFFICIENT GENERATOR

THESIS

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Air University

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In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Electrical Engineering

Ricardo Mediavilla, BS

Second Lieutenant, USAF

March 1999

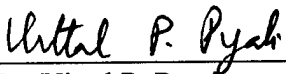
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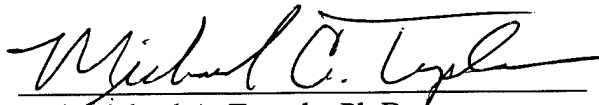
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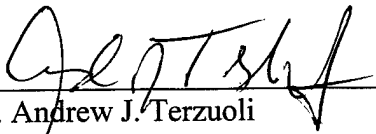
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Preface

This research proposes a simple backscattering coefficient (σ^0) generator for several radar bands, types of terrain, and wave polarizations for angles of incidence up to 80° . The generator is based on an extensive database of σ^0 measurements [8]. This generator was first proposed and successfully used by Wilson for nine terrain types, X-band radar, and VV polarization [11].

This research expands the generator's capabilities by adding six radar bands and the three types of wave polarizations (HH, HV and VV) for all nine terrain types. A method to automate validation of the generated distributions based on a modified chi-square test was developed.

Parallel to this research effort is the work of O'Connor (to be published). The mentioned research successfully applied modified sea clutter models to extend the measured σ^0 curves to the grazing angle region ($\theta > 80^\circ$). The "production" σ^0 generator features this improved grazing angle simulation capability.

I want to thank Capt. Kelce Wilson for the invaluable help to create a tool that will find good use among the people interested in backscattering coefficient measurements.

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Ricardo Mediavilla

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Abstract

Using already available data, a backscattering coefficient (σ^0) generator for several types of terrain and measurement conditions is developed. The types of terrain are 1) soils and rocks, 2) trees, 3) grasses, 4) shrubs, 5) short vegetation, 6) roads, 7) urban areas, 8) dry snow, and 9) wet snow. These data sets typically cover incidence angles ranging between 0° and 80° where 0° is normal to the terrain. Measurement conditions are defined by 1) incidence angle, 2) wave polarizations configuration (HH, HV, or VV), and 3) radar band (L, C, S, X, Ku, Ka, or W). The σ^0 generator output matches very closely the first and second moments of the published data.

A modified chi-square goodness of fit test at a 0.05 significance level is introduced to automatically validate the generated output with measured data histograms. Contrary to an ordinary chi-square test previously applied, the modified test rejection rate was consistent with expected behavior of simulated and measured data graphs as the number of source data points (N) increased. The modified test failed to reject the proposed generator as representative of the measured data for an average 72% of all simulated distributions having $N \geq 100$. Noted discrepancies can be attributed to sparse σ^0 data histograms and model limitations in the $0^\circ \leq \theta \leq 20^\circ$ for certain terrain types.

The σ^0 generator is a realistic simulation tool of terrain backscattering statistics since it portrays terrain's true probabilistic nature.

TERRAIN BACKSCATTERING COEFFICIENT GENERATOR

I. Introduction

Background

The backscattering coefficient (σ^0) is a measure of the electromagnetic energy scattered from a distributed target in the receiver direction. In general, σ^0 is dependent upon target shape, degree of roughness, dielectric constant, viewing geometry, scattering center location, and the attributes of the transmitted and scattered electromagnetic waves (wavelength, polarization, and incidence angle) [8]. In this research, the backscattered energy from a terrain patch of definite area is of interest.

The scattering centers of a terrain patch are randomly distributed and vary in position with frequency and incidence angle [8]. These characteristics give σ^0 its random quality. The reader can envision such an effect by placing some glitter on a piece of paper. When illuminated, it will become evident that at any specific "look-angle" only certain glitter grains flicker. These "scattering centers" on the piece of paper contribute to the paper's " σ^0 ". These σ^0 characteristics justify its description as a mean value calculated upon several measurements at an incidence angle, frequency, and wave polarization. These will be referred as *measurement conditions*. The value of σ^0 is also influenced by seasonal variations of vegetation biomass [8]. This inherent dependence of σ^0 on terrain characteristics has found generalized use as indicator of crop maturity, terrain humidity, and other uses.

The potential applications of σ^0 have motivated numerous studies and papers dealing with its measurement and theoretical models. Measurement of σ^0 has been a tough task because of the randomness of the process itself, as well, as the calibration issues involved. Early efforts by Ohio State University and other research groups focused mainly in the $10^\circ \leq \theta \leq 80^\circ$ where θ (incidence angle) is measured from normal incidence. Experiments to collect σ^0 data at grazing angles ($80^\circ \leq \theta \leq 90^\circ$) are very scarce [7]. Nevertheless, the measurement of σ^0 has become an active area of radar research because of its potential military and environmental applications. Military applications arising from the theory and measurements of σ^0 focus in the development of accurate target recognition techniques. Environment sensing applications are being applied to optimize the use of natural resources.

In this research, the measured σ^0 data source is the *Handbook of Radar Scattering Statistics for Terrain* [8]. This book features a comprehensive database of σ^0 measurements for several types of terrain and measurement conditions. These data measurements were collected from several studies spanning several years and intents. The database portrays the statistical properties of σ^0 measurements as a mean σ^0 and associated $s(\theta)$. Frequencies of occurrence histograms describe the distribution of the σ^0 values. The classifications for terrain are: (1) soil and rock surfaces, (2) trees, (3) grasses, (4) shrubs, (5) short vegetation, (6) roads, (7) urban areas, (8) dry snow, and (9) wet snow. The conditions for data inclusion into the database are comprehensive and well explained in Chapter V of the mentioned reference [8:79].

This research proposes a σ^0 generator that is constructed upon the compiled data in [8]. The user of the σ^0 generator must specify (1) type of terrain, (2) wave polarization, (3) incidence angle, (4) radar band, and (5) a $U(0,1)$ random variable. These will be called *generator input set* (GIS). The generator produces a value of σ^0 in decibels. Note that to obtain the published mean σ^0 and $s(\theta)$ for a GIS, sufficient σ^0 values must be generated.

In his doctoral dissertation, Wilson first proposed and used a prototype σ^0 generator for all types of terrain listed above but limited to X-band and VV polarization [11]. This research applies previously established concepts to expand the generator's capabilities to include nine terrain types (described above), six additional radar bands, and the full set of linear wave polarizations, namely horizontal-horizontal (HH), horizontal-vertical (HV), and vertical-vertical (VV). The generator output is tested for goodness-of-fit against the measured data available using a chi-square hypothesis test with encouraging results.

Problem Statement

Develop a backscattering coefficient (σ^0) generator that will emulate measured σ^0 data. The σ^0 generator should be designed with a minimum 1° angular resolution. The generator output statistics should match the first and second moments of the published data in [8] when a sufficient number of samples are generated. The generator should output σ^0 values for all three pairs of linear polarizations, seven radar bands, and nine types of terrain. Generated output distributions should be similar to the frequency of occurrence histograms of measured data. Validate generated distributions using a chi-square goodness-of-fit test for all incidence angles where data exists. Generator should

be autonomous such that new σ^0 data and generated histogram validation may be done with minimum user interaction.

Scope

Limit data to the aforementioned nine terrain types, seven radar bands, and the full set of linear polarizations, as tabulated in [8]. The σ^0 generator algorithm should be coded in FORTRAN.

Assumptions

It is assumed that the database in [7] is accurate.

General Approach

The σ^0 generating function is defined by

$$\sigma = \beta \cdot (-\ln(U)^\alpha) + \gamma \quad (1)$$

where β is an amplitude term, α is a skewness parameter, γ is a distribution adjustment quantity, and U is a uniform $U(0,1)$ random variable. The mean of the function over an ensemble of $U(0,1)$ random numbers in (1) represents the mean σ^0 , while its standard deviation represents the standard deviation of the mean σ^0 , namely $s(\theta)$.

The mean σ^0 and $s(\theta)$ values contained in [8:119-356] are typically provided in angular increments of 5 and 10 degrees. A method of interpolation by cubic splines is applied to the data to achieve the required 1° angular resolution. Cubic spline interpolation was chosen on the basis of smoothness and its inherent ability to connect all measured data points.

The α , β , and γ values are selected such that all interpolated values of the mean σ^0 and $s(\theta)$ sequences can be generated by (1). An optimization algorithm is used to

determine which α - β combination (for a fixed γ value) generates the desired σ^0 and $s(\theta)$ with minimum error. The generated distributions are tested for goodness-of-fit using a chi-square test. If a generated distribution is rejected, parameter γ is either increased or decreased to adjust the output histogram of (1) such that it fits the measured data histograms satisfactorily. Manipulation of γ has some practical limitations that are discussed in Chapter IV.

Sequence of Presentation

A literature review about σ^0 and its statistical models and a brief description of some of its applications take place in Chapter II. A description of Equation (1) will be given in Chapter III. The algorithms used to find the appropriate α - β sets are developed and explained in this chapter. Presentation and analysis of the results follow in Chapter IV. To end this journey, conclusions and recommendations are given in Chapter V.

II. Literature Review

In the early years of radar development, it became evident that unwanted clutter originating from electromagnetic waves echoing back from terrain and sea needed to be accounted for in radar system design. Efforts to quantify clutter and its characteristics support radar systems engineering and more recently, aid in the monitoring of terrestrial phenomena.

Backscattering Coefficient (σ^0)

The radar range equation describes the relationship between the transmitted power P_t to a point target at a range R and the power P_r detected by the radar receiver [7]

$$P_r = \frac{P_t G_t}{4\pi R^2} \cdot \frac{\sigma_{RCS}}{4\pi R^2} \cdot A_e \quad (2)$$

The quantities G_t and A_e represent the transmitting antenna gain and the receiving antenna's effective aperture area, respectively. The quantity σ_{RCS} is the target's radar cross section (RCS) in units of meter squared (m^2).

The RCS of a target depends on radar system characteristics such as direction of illumination, wavelength, and polarization [7]. Also, a target's RCS depend on the complex permittivity, degree of roughness, and viewing geometry. In mathematical terms, the RCS is defined as [8]

$$\sigma_{pq} = \lim_{R \rightarrow \infty} \left(4 \cdot \pi \cdot R^2 \frac{S_p^s}{S_q^i} \right) \quad (3)$$

where the subscript p and q refer to the polarization of the scattered and incident waves, respectively. The quantity R is the radar to target distance. S_p^s and S_q^i are the scattered and incident power densities, respectively. The scattered power density (numerator of

equation) varies as R^{-2} , rendering Equation (3) independent of range [7]. The limit notation denotes that the RCS is a far field quantity. The set of linear polarizations (HH, HV, and VV) is used to be consistent with the convention in [8].

By using the relationship

$$S = \frac{|E|^2}{\eta} \quad (4a)$$

where η is the air impedance and E is the electric field intensity, we have

$$\sigma_{pq} = \lim_{R \rightarrow \infty} \left(4 \cdot \pi \cdot R^2 \frac{|E_p^s|^2}{|E_q^i|^2} \right) \quad (4b)$$

where p and q are substituted by HH, HV, or VV as appropriate. Note the reciprocity in the terrain backscattering process for HV and VH polarizations [8]

$$\sigma_{hv}^o = \sigma_{vh}^o \quad (5)$$

A more convenient measure of RCS for distributed targets is the backscattering coefficient, σ^o , defined as [8]

$$\sigma_{pq}^o = \frac{\sigma_{RCS}}{A} \quad (6)$$

where A is the area covered by the antenna's footprint on a reasonably flat surface [10]. This causes σ^o to be independent of the radar's geometric parameters (pulse width, beamwidth, etc.) [7]. In this research, the definition of σ^o as in Equation (6) will be used (Figure 1).

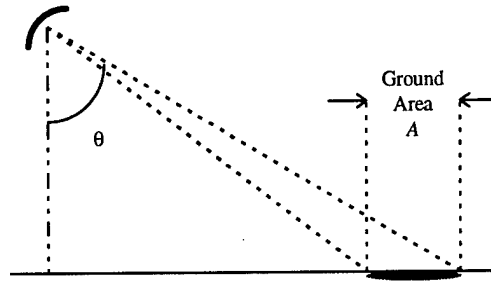


Figure 1. Data collection geometry.

Scattering Mechanisms

Several theories attempt to explain the interaction of electromagnetic waves and terrain. Although a thorough discussion of these is out of the scope of this document, the facet theory of scattering will be briefly described.

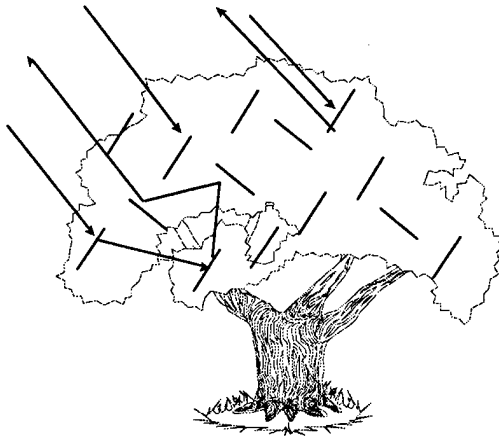


Figure 2. Simplified facet scattering model.

This theory models an object by a number of facets tangential to the object's surface. The centers of the facets constitute scattering centers. The total scattering is computed by determining the re-radiation patterns and slope of each facet. Figure 2

displays a highly simplified facet model for a tree canopy. The facets can be large or small relative to wavelength. As the wavelength increases, a given facet will change from large to small. The overall effect of the increase in wavelength is the apparent smoothening of the surface. When the transmitted signal is narrow-band and coherent, the received signal will be the phasor sum of each facet (or scatterer) contribution [7].

Dependence of σ^0 on Terrain Characteristics

The σ^0 values for a distributed target are determined by its electromagnetic and physical attributes. The σ^0 of a co-polarized scatter (HH and VV) exhibits three distinct regions, namely "quasi-specular", "plateau" region, and a "shadow" region (Figure 3). In

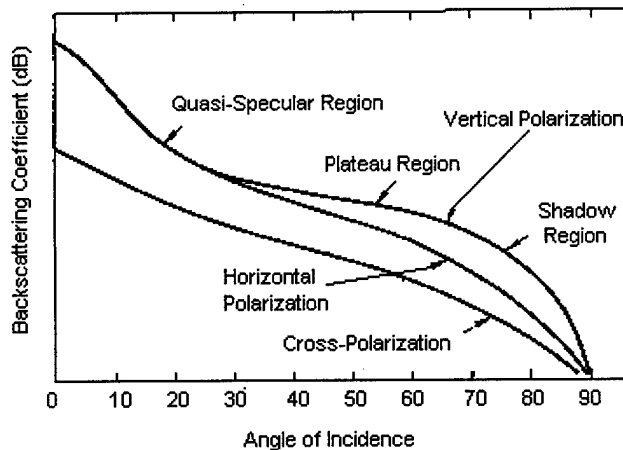


Figure 3. Typical σ^0 Curves [8].

For smooth surfaces, the σ^0 exhibits a strong return in the quasi-specular region that decays rapidly as the angle of incidence, θ , increases. For rough surfaces, the change in σ^0 as θ increases is of much smaller magnitude. Generally, the σ^0 curve exhibits a slight negative slope [7].

Terrain moisture greatly influences the amount of scattered energy. For a distributed target, the value of σ^0 increases as the moisture content increases and viceversa [8]. This is a consequence of the larger microwave dielectric constant of water relative to that of the holding surface. This property has been useful as a terrain humidity indicator. For instance, a study at the Freiburg test site, Upper Rhine Valley, Germany

general, the σ^0 of a cross-polarized scatter (HV) does not exhibit the same distinct regions as the co-polarized scatter [7]. The most important details about σ^0 response based on terrain characteristics will now be summarized. This summary will follow [8] closely.

showed strong positive correlation between σ^0 and soil moisture content at microwave frequencies [6]. A satellite-based system was used to measure σ^0 .

For the most part, surfaces covered by vegetation have a σ^0 response mainly due to the canopy, and to a lesser degree, to the underlying soil. As the vegetation canopy thins, the σ^0 contribution from the soil increases, changing σ^0 [7]. The thinning of vegetation decreases the σ^0 response of a distributed target. A case in point is a study of Les Landes Forest, France (L band) [2]. This study showed that forest thinning contributed to σ^0 reduction of up to 4 dB, most noticeably for HV polarization. Thinning involves decreasing tree population, which induces a change in mean tree height and a change in the trunk diameter distribution. Also, thinning causes canopy structure modifications such as rearrangement of tree's crowns and the clearing of vegetation above ground level. The authors theorize that this could be responsible for the σ^0 decrease.

Snow exhibits a σ^0 signature that changes with the observation wavelength. If the wavelength is large compared to the internal structure of the snow layer (such as L band), the σ^0 will be largely from the underlying soil. This changes as the wavelength becomes smaller (Ka band). The σ^0 response will resemble that of a rough surface since the snow structure becomes the main source of backscatter. Moisture also has a significant impact on snow's σ^0 . For two samples of snow of differing moisture content, the σ^0 response will be stronger for the drier sample as the wavelength increases. This difference is greatest at small wavelengths (Ka band) [8].

Urban areas are hard to describe using σ^0 since many structures in such an environment have deterministic shapes that can behave as strong point targets [7]. These

point targets scatter energy that dominates over the total scattered energy from all other scatterers present. The theory to handle this situation is different to that of other terrain types. For example, a recent study of the urban characteristics of Sydney, Australia computed theoretical σ^0 signatures from urban areas using deterministic methods [4]. This investigation identified single bounce scattering from surfaces such as roofs, double bounce from ground-wall structures, and other metallic elements as principal radar scattering contributors. A better understanding of urban area scattering will enable monitoring and precise classification of such areas.

Other method to quantify scattering from urban areas is to measure the σ^0 response of an urban conglomerate and average the return over wide areas. Then, the scanned areas could be classified as residential, commercial, or industrial [7].

Statistics of Ground Clutter

Most clutter theories assume that a patch of terrain is large enough to contain a significant number of randomly localized scatterers [7]. These scatterers produce a signal at the receiver whose envelope behaves like random noise due to fading effects. (Fading refers to the wide variations in the received signal's envelope due to phase-shift changes; in turn, these are caused by look-angle changes relative to the illuminated area due to platform movement.) Therefore, the statistics of random noise can be used to model the scattered signal being received, namely, the Rayleigh clutter model [7].

The application of the Rayleigh clutter model is based on a set of assumptions discussed in [8] and reviewed here for convenience:

(1) It is assumed that the individual scatterers are independent of each other. Any interactions between adjacent scatterers is ignored. Hence, the total instantaneous electric field is expressed as the sum of each scattered electric field.

(2) The maximum extent of the target under scrutiny is much smaller than the mean range from the antenna to the target. The antenna is assumed to have uniform gain across the target area.

(3) As stated before, a distributed target contains a large number of scatterers. The amplitude and phases of the scattered electric fields are considered independent. This last condition is satisfied by having the scatterers randomly distributed across the target's area. At least ten scatterers are necessary to ensure that the orthogonal components of the electric field are normally distributed [8].

(4) The phase must be randomly distributed between $[0, 2\pi]$. This can be accomplished by choosing the target's extent to be several wavelengths across. The target is also assumed to have randomly located scatterers.

(5) No single scatterer center produces an electric field intensity that dominates the total scattered field from the distributed target.

These assumptions lead to the Rayleigh clutter model:

$$f(E_e) = \frac{E_e}{s(\theta)^2} e^{\frac{-E_e^2}{2s(\theta)^2}}$$

$$f(\phi) = \frac{1}{2\pi} \quad 0 \leq \phi \leq 2\pi \quad (7)$$

$$\overline{E_e} = \left(\frac{\pi}{2}\right)^2 s(\theta)$$

where $f(E_e)$ is the probability density function (PDF) of the total electric field magnitude before detection at the receiver. The second equation, $f(\phi)$ is the PDF for the phase, while $\overline{E_e}$ denotes the average value of E_e . The variance of E_e is denoted by $s(\theta)^2$ and the standard deviation, $s(\theta)$, is just the square root of the variance.

The Rayleigh clutter model may not be applicable to forest or urban scenes where some scatterers may dominate the return at certain frequencies and incidence angles [8]. The Ricean PDF is used when one or a few strong scatterers exist within the observed target. Other PDF models that are often used include the Weibull and log-normal.

Approximate σ^0 Models

In this section, the various theoretical and empirical models published by several σ^0 studies will be explained.

The following set of equations describes behavior of σ^0 of the combined observations of space station Skylab's radiometer-scatterometer (RADSCAT) and University of Kansas' truck mounted microwave active spectrometer (MAS).

The model is representative of summer conditions averaged all over North America:

$$\sigma_{dB}^o(f, \theta) = A + B \cdot \theta + C \cdot f + D \cdot f \cdot \theta \quad 20^\circ \leq \theta \leq 70^\circ$$

$$\sigma_{dB}^o(f, \theta) = M(\theta) + N(\theta) \cdot f \quad \theta = 0^\circ, 10^\circ$$

where f is the frequency and θ is the incidence angle. The indicated range of incidence angles for both equations determines the values of the A , B , C , D , M , and N coefficients. The loading parameters for both equations can be found in [8]. The σ^o value for an incidence angle $0^\circ < \theta < 10^\circ$ and $10^\circ < \theta < 20^\circ$ is found by interpolating the resulting curve.

Several studies have investigated the potential applications of radar for moisture sensing of vegetation covered soils. The following model represents the σ^o response of a soil surface covered by vegetation [9]:

$$\sigma^o = T^2 \cdot \sigma_s^o + \sigma_{dv}^o + \sigma_{int}^o$$

where T^2 is the two-way attenuation effect due to the vegetation layer, σ_s^o is the backscattering contribution of the soil underneath, σ_{dv}^o is the direct backscatter contribution of the vegetation cover, and σ_{int}^o represents multiple scattering due to soil-vegetation canopy interactions.

The last model for σ^o to be reviewed models the σ^o measured over bare soils, taking into account soil moisture and incidence angle [1]:

$$\sigma_s^o = C_1 + C_2 \cos(\theta)^{C_3} + dm_v$$

where C_1 , C_2 , and C_3 correspond to the backscattering coefficient of dry soil for $\theta = 90^\circ$, the total dynamics of soil response over the $0^\circ \leq \theta \leq 60^\circ$ range, and a shape factor,

in volumetric soil moisture. Other important details of the formulation are found in the reference article.

Summary

The papers mentioned in this chapter represent a small sample of the available literature related to σ^0 measurements. Several efforts are directed towards remote sensing applications that seek to optimize the use of the limited earth resources. Also, military applications arising from the theory and measurements of σ^0 logically follows. Target recognition technologies seek to precisely identify targets camouflaged on the ground. Hence, an understanding of ground clutter, as quantified by σ^0 , and of the scattering mechanisms is crucial to create effective target acquisition algorithms. In the next chapter, a method of simulating σ^0 values based on measured data is introduced. In contrast to some models described in this chapter, the σ^0 generator behaves in a statistical manner, yielding histograms similar to those of measured data.

III. Backscattering Coefficient Generator Development

The developmental aspects of the σ° generator are explained in this chapter. The main idea behind the σ° generator is to determine a functional form that can simulate the first and second moments of the backscattering process for various terrain types in a statistical way. By "statistical" it is meant that the generator returns a σ° number that is different every time it produces such a value. Further, the frequency of occurrence histograms of the generated σ° values must be similar to those of measured σ° histograms when the generator produces enough samples.

Model Formulation

The following equation is the functional form described in (1) and repeated here for convenience:

$$\sigma = \beta \cdot (-\ln(U)^\alpha) + \gamma \quad (8)$$

The first step in this process is to generate an array (or surface) of values that for possible α - β - γ combinations yields the required mean σ° and $s(\theta)$ values. Each surface is constructed for a fixed γ value. To illustrate, a typical set of values follows:

$$\alpha = 0.06, 0.061, 0.062, \dots, 2.0 \quad (8a)$$

$$\beta = 0.01, 0.011, 0.012, 0.013, \dots, 14.0 \quad (8b)$$

$$\gamma = 0.01 \quad (8c)$$

For each combination of α , β , and γ , an average is calculated upon feeding (4) with an ensemble of $U(0,1)$ randomly generated numbers.

Equivalently, an ordered series is input to (8) having the form

$$\text{Construction Series} = \left\{ \frac{1}{N}, \frac{2}{N}, \dots, \frac{N-1}{N} \right\} \quad (9)$$

Previous research established that using a readily available uniform $U(0,1)$ generator will not produce a stable α - β set for a given γ [11]. Use of a uniform random number generator at this stage introduced unacceptable variability to the process, making it difficult to determine the optimal α - β - γ set. Equation (9) can be thought of as an ordered collection of random values from a "stable" uniform $U(0,1)$ random number generator. In [11] it was established that a value of $N \approx 100,000$ produces a stable α - β - γ set. In order to speed up the computational process, $N = 1000$ was successfully used. This procedural convenience did not affect the desired characteristics of the σ^o generator. Testing of the σ^o generator used in combination with a uniform random number generator converged to the published mean σ^o and $s(\theta)$ values when enough samples were produced.

The resulting sequence is converted to decibels by using:

$$\sigma_i^o (dB) = 20 \log_{10} (\sigma_i) \quad (10)$$

The sequence of values in (10) is then averaged to yield the mean σ^o value [3]

$$\bar{\sigma}^o = \frac{1}{n} \sum_{i=1}^n \sigma_{i(dB)} \quad (11)$$

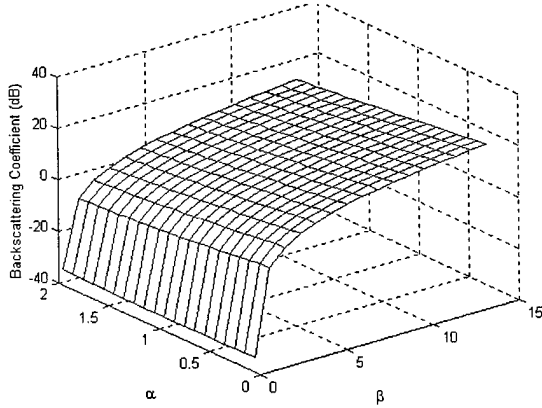


Figure 4. Array of Mean σ^o Values.

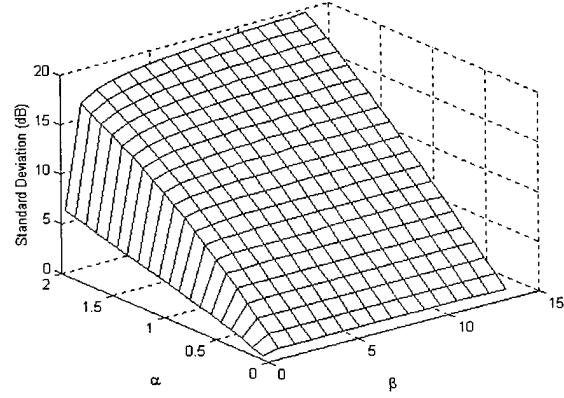


Figure 5. Array of $s(\theta)$ Values.

The standard deviation of the ensemble, $s(\theta)$, is given by:

$$s(\theta) = \left[\frac{\sum_{i=1}^n (\sigma_{i(dB)} - \bar{\sigma}^o)^2}{n-1} \right]^{\frac{1}{2}} \quad (12)$$

Each mean σ^o and $s(\theta)$ value is built into the two-dimensional arrays according to their α - β values (Figures 4 and 5). The abscissa and ordinate correspond to β and α , respectively. For example, suppose a set of α - β - γ values is specified: α_1 - β_1 - γ_1 (keep in mind that each surface is built for a fixed γ value). Each resulting mean σ^o and $s(\theta)$ values have α_1 - β_1 coordinates within their respective arrays. These surfaces constitute "search grids" or surfaces where an exhaustive search seeks to determine an α - β pair that yields the published mean σ^o and $s(\theta)$ values with minimum error.

An adequate measure of the error for this process is given by [11]

$$error = \frac{A - B}{B} \quad (13)$$

The value A represents a proposed value for a variable (i.e., $A = \sigma^o$ or $A = s(\theta)$) while B is the desired (or measured) value. A measure of error is obtained for both, mean σ^o and $s(\theta)$ surfaces, by subtracting and normalizing these by the mean σ^o or $s(\theta)$ value of interest:

$$error = ABS \left(\frac{\begin{bmatrix} 1 & \rightarrow & N \\ \downarrow & & \downarrow \\ M & \rightarrow & MN \end{bmatrix} - B}{B} \right) \quad (14)$$

where the array of dimension MN can be either the σ^o or $s(\theta)$ array (surface). B is the desired σ^o or $s(\theta)$ value, while ABS stands for absolute value.

The total error (TE) is given by

$$TE = \sigma^o error + s(\theta) error \quad (15)$$

where $\sigma^o error$ and $s(\theta) error$ are calculated using Equation (14). The TE array is a surface of the error incurred given the calculated and desired mean σ^o and $s(\theta)$ values (Figure 6). The search algorithm finds the minimum combined error and determines which α - β pair produced this minimum value. Notice the minimum error combination at $\beta \approx 1$ and $\alpha \approx 0.5$ (Figure 6). The algorithm further refines the estimate until the desired level of decimal accuracy is reached. The algorithm will also stop after it exceeds a pre-set threshold and a satisfactory α - β pair has not been found.

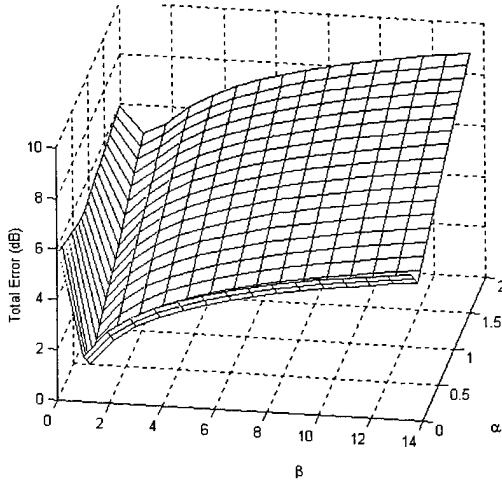


Figure 6. Total Error Array

In [11], it was found that a search grid that is dense for small values of α - β and sparse for large values of these variables provides an adequate search surface. Alternatively, a "partial surface" approach was tested. In this method, only those areas in the surfaces that contained the mean σ^0 and $s(\theta)$ values of interest were kept. However, this method failed to converge to α - β - γ sets that produced minimum error combinations for the values of interest. The variable density search method was used instead with the expected results. The use of variable density search spaces results in computational timesaving.

Properties of σ^0 Generating Function

Equation (8) has a discrete output dependent on the α - β - γ combinations and the ensemble of $U(0,1)$ random values. A histogram of the output indicates that the resulting distributions can be regarded as Weibull (Figure 7). A percentile plot suggests this to be true (Figure 8), which is representative of most generated distributions [3]. The α - β - γ values determine the shape of the function's histogram. The value of γ can be increased or decreased to adjust the shape of the generated histogram and conform it to the

The criterion used to select the range of α - β - γ values is based on experimental experience. In this research, it was found that by extending the α sequence to include values smaller than 0.16 (i.e., 0.06) convergence was possible for all distributions.

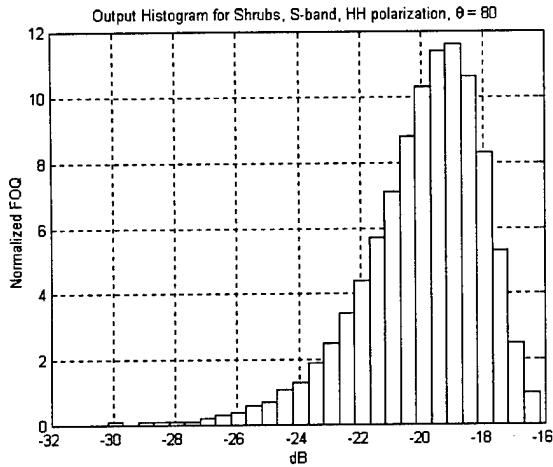


Figure 7. σ^0 Generator Output Histogram.

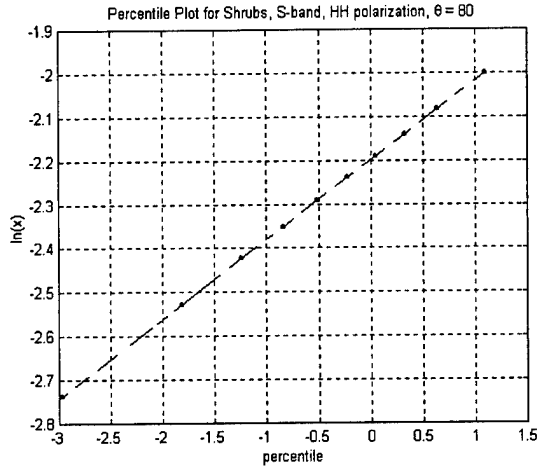


Figure 8. Percentile Plot of σ^0 Generator Output in Figure 7.

measured data histogram. Adjustments to γ have little effect when the generated histogram's shape departs significantly from the measured data histogram. The bin width of the histograms is 0.5 dB.

Data Quality and Pre-Processing

The data used in this research represents a calibrated compilation of σ^0 measurements from several studies [8:79]. It is the most comprehensive to date, although data quantity varies by terrain type and measurement conditions.

The data sets were qualified by evaluating whether the mean σ^0 and $s(\theta)$ data points could be interpolated to yield "reasonably" shaped curves (such as seen in Figure 3). A *data set* is any table entry such as "I-5, X Band, HH Polarization" from the reference database [8:91]. The number of source data points (N) supporting each mean σ^0 value and the shape of the interpolated curves were also considered. This data pre-processing was necessary due to the high variability in N within and across data sets (Figure 9) [8].

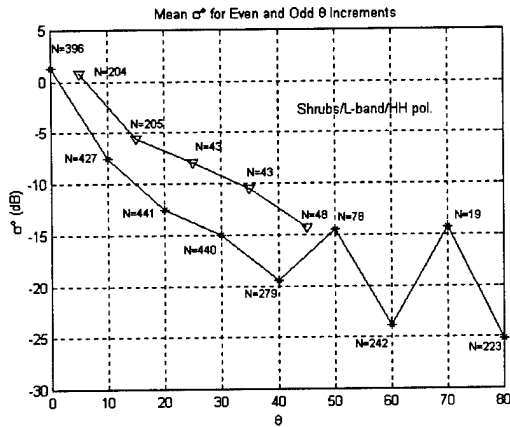


Figure 9. Partition of Data Points by Even and Odd Incidence Angles.

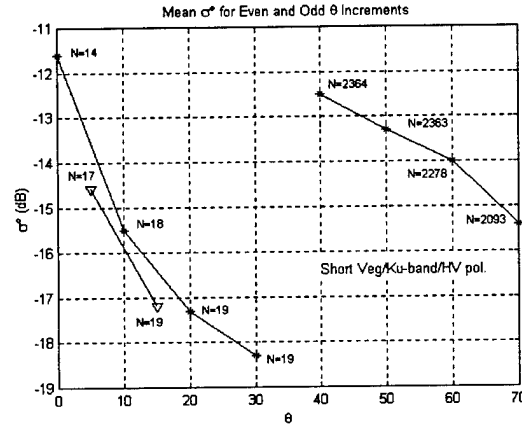


Figure 10. Partition of Data Points as in Previous Figure.

The mean σ^0 curve's shape is strongly linked to N (Figures 9, 10, and 11). Note that the $s(\theta)$ curves also reflect the same anomalies as the σ^0 curves (Figure 12).

Figure 10 shows cases where the σ^0 data sets have markedly different N for the first six data points, yielding a highly irregular mean σ^0 curve. This curve was corrected by discarding the five degree increments and raising the remaining σ^0 data points by an amount such that the resulting curve had the characteristic mean σ^0 contour. A similar process was applied to other mean σ^0 curves exhibiting the same behavior.

A case where no data point was discarded is illustrated in Figure 11. Inclusion of the data point $\theta = 30^\circ$ did not cause significant degradation of the interpolated mean σ^0 curve.

Another pre-processing example is provided by Figure 12. At first glance, the data points at $\theta = 50^\circ$ and 55° seem to be outliers. However, these mean σ^0 values were generated with a higher N than the rest of the points. One could rightly argue that the higher the number of sample data points, the closer the measurement would be to its real

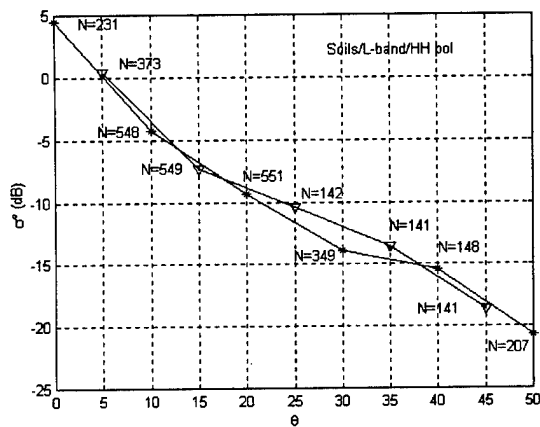


Figure 11. σ^0 Curve for Soils

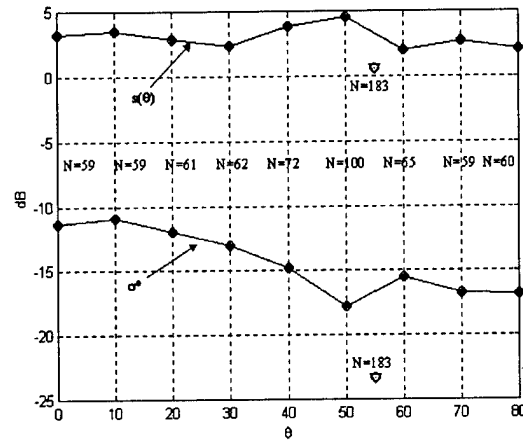


Figure 12. σ^0 and $s(\theta)$ Curves for Trees, X-Band, HV Polarization

value. However, it was decided to discard these data points in favor of the remaining others. Keeping the majority of the data points provided us with more instances to test the σ^0 generator's simulation capabilities. Moreover, this assures that the σ^0 generator output follows closely the accepted theory.

Simulation of the data collected over urban areas presented a special situation. Analysis of the data indicated badly behaved mean σ^0 curves. This is no surprise since the database authors warn readers that the mean σ^0 curves of urban areas may not portray accurately the true backscattering response of this terrain type. It is reasonable to infer that these urban areas may contain strong corner reflectors (buildings, wall layouts, etc.) which may influence measurements at certain radar frequencies and incidence angles. Incidentally, this terrain type has the one of the lowest number of supporting studies in the database, i.e., lowest N. This terrain type is included in this research for experimental purposes [8:87].

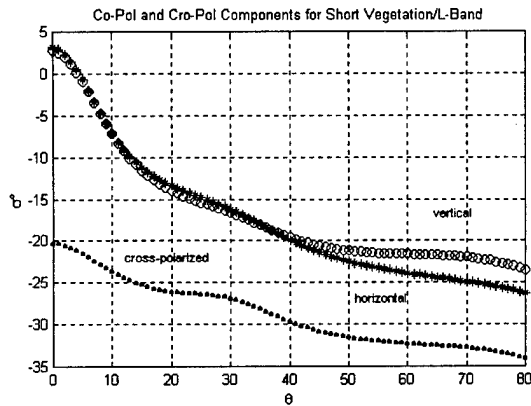


Figure 13. Spline Interpolation of σ^0 Data Points for Short Vegetation.

In general, the ten-degree increments were the best documented in the database, as well as the group to approximate closely the theoretical curve behavior. Hence, these were the σ^0 data source points most often used.

Interpolation of the mean σ^0 and $s(\theta)$ curves was necessary to achieve the required 1° angular resolution. The primary reference applies an iterative least squares and non-linear curve-fitting routine to interpolate these curves for all incidence angles [8]. However, it is desired to accurately reproduce the mean σ^0 and $s(\theta)$ measurements at each angle where data is available. Hence, an alternative method of interpolation by cubic splines was used. A spline curve fitting routine connects every known data point with a smooth curve that yields a good approximation to the theoretical σ^0 curves shown in Figure 3. For these purposes, MATLAB[®]'s *spline* routine was used. In Figure 13 a "best case" interpolation example is shown for short vegetation at L-band, which closely resemble the curves in Figure 3.

A similar problem as the one described above for σ^0 data points from angle to angle within a data set occurs across data sets. In other words, for the same terrain type, radar band, and incidence angle, N generally differs for HH, HV, and VV polarizations. Such an instance is illustrated by shrubs at $\theta = 5^\circ$ (L band), $N = 204$, 74, and 160 for horizontal, cross, and vertical polarizations, respectively [8:200]. This peculiarity reflects on the σ^0 measurement history rather than on the database's completeness. This may explain why the resulting shape of the interpolated curves can be irregular.

After applying the analysis outlined above, 129 data sets out of 155 were deemed qualified for interpolation and subsequent processing.

Validation of Results

A multinomial test of proportions was implemented to test how well the generated histograms (output of Equation 8) matched the measured (*observed*) data histograms. This is a chi-square goodness-of-fit test variation where two distributions having a different total number of counts are compared. For instance, the output of the generator was generally about 100,000 counts. The observed counts (same as N) varied from the low tens to approximately 5,000 observations per histogram. To assess distribution likelihood between generated and observed count histograms, the predicted counts histogram is normalized. Then, each of its bins is multiplied by the total number of observed counts. Consequently, the sum of all generated (or *predicted*) counts equals the total number of observed counts. Predicted and observed counts are grouped in histograms having k bins or cells. Each bin has width of 0.5 dB, consistent with the database's convention [8].

Next, a null hypothesis and an alternative hypothesis are proposed. The null hypothesis is that the predicted counts histogram is a good fit to the observed counts histogram. The alternative hypothesis logically follows [3:586].

The following test statistic is used to test the null hypothesis:

$$\chi^2 = \sum_{\text{all cells}} \frac{(\text{observed} - \text{predicted})^2}{\text{predicted}} \quad (16)$$

The test statistic value is compared to the chi-square value obtained from tables or from a computerized algorithm. The null hypothesis is rejected when the test statistic is larger than the chi-square value.

The chi-square value depends on two factors: the level of significance and the number of degrees of freedom. The level of significance can be regarded as the tolerance of the test. A level of significance of 0.05 is used in this research, which is considered a high level. In other words, if the null hypothesis can not be rejected, we can be 95% confident that this result was not due to chance. The number of degrees of freedom is defined as $k-1$ where k is the number of bins per histogram [3:586].

In a chi-square test, each bin must have a minimum number of counts. In this research a minimum number of one is used [5:711]. Due to the normalization of the generated data, the number of predicted counts in any one bin may be less than one. Adjacent bins are combined together to achieve the minimum number of counts. The observed count bins are collapsed accordingly.

IV. Experimental Results

This section discusses the results and issues encountered in the σ^0 generator development. The main focus in this investigation is to develop the σ^0 generator for all types of terrain and measurement conditions published in the database [8].

Experimental Data Validation

Short Vegetation, Ku-Band, HV, $\theta = 50^\circ$, $N=1715$

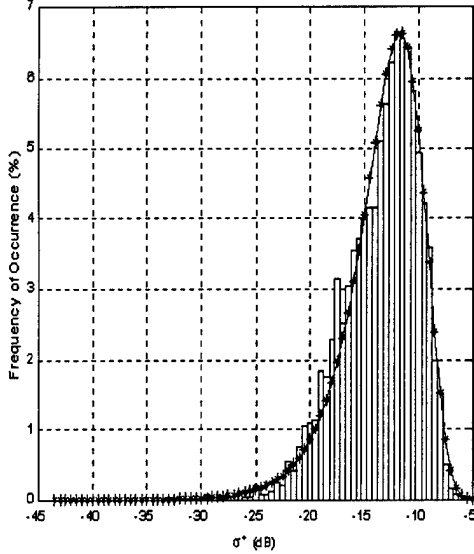


Figure 14. $TS = 74$. $NTS = 3.2$. $\chi^2 = 64$

Several issues ensued in the validation phase. Perhaps, the most significant problem was the mixture of well and poorly documented incidence angles within a data set. Although a data set may have been qualified after pre-processing, this does not imply that all of its data points were supported by a high N (see Chapter III, Data Quality and [8:210,215]).

Validation results were affected by the value of N . As N increased (hundreds to thousands), any small deviation between the predicted and observed counts histograms resulted in rejection of valid null hypotheses. This is shown in Figure 14, where TS is the test statistic, NTS is the normalized test statistic (to be discussed shortly), and $\chi^2_{\alpha, k-1}$ is the chi-square value.

On the other hand, when the measured counts were low ($N \leq 100$) the test did not reject ambiguous or invalid null hypotheses in almost all instances (Figure 15). Visual

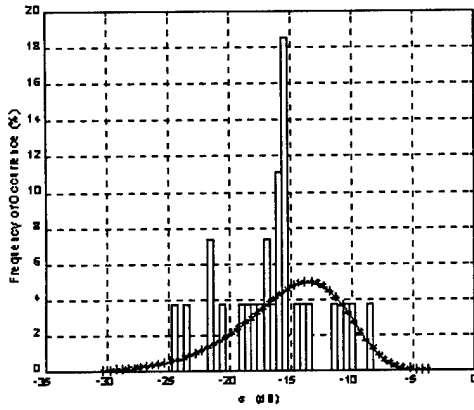


Figure 15. Grass/S-Band/HV pol./ $\theta = 5^\circ$,
 $N = 27$, TS = 25. NTS = 92. $\chi^2 = 31$.

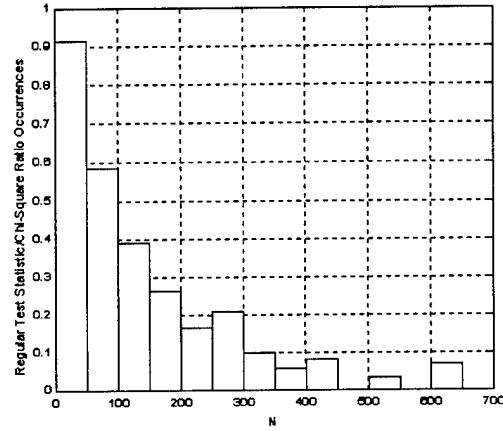


Figure 16. Chi-square Test Success Rate
 Distribution

inspection of the histograms indicated that a reasonable conclusion could not be reached due to the low number of observed samples and sparse histograms.

The chi-square test seemed to be prone to reject the null hypothesis when N was high and viceversa. To test this suspicion, a ratio test was devised:

$$\text{ratio test} = \frac{\chi^2}{\chi_{\alpha, k-1}^2} \quad (17)$$

where the numerator is the test statistic in Equation (16) and the denominator is the chi square value for a significance level α and $k-1$ degrees of freedom. When the null hypothesis is not rejected, the numerator will be smaller than the denominator yielding a ratio less than one. The opposite occurs when the null hypothesis is rejected. The histogram in Figure 16 shows what fraction of chi-square tests within each bin yielded a ratio test less than one. It is seen that the validation test tends not to reject the null hypothesis when N ranges in the low tens and hundreds. The test behavior was incompatible with the goal of validation process automation. An alternative approach, a

modified chi-square test, was tested and implemented. This test yielded good results for a greater range of N values as confirmed by a detailed review of all validation test results.

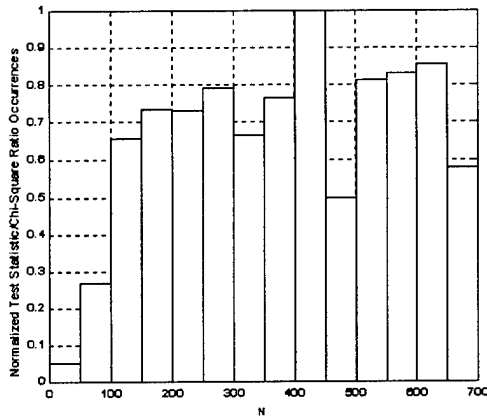


Figure 17. Normalized Chi-square Non-rejection Rate.

The test is implemented as an ordinary chi-square test except that both, *predicted* and *observed* bin counts, are normalized to one hundred. Due to this normalization, the test statistic in Equation 16 is called the normalized test statistic (NTS). This test performed better than the regular chi-square test, especially for low N.

Figure 17 shows the ratio test results for the normalized chi-square test (Equation 17). It is seen that the test's success rate is better distributed along the range of samples shown.

However, the modified chi-square test did not reject inconsistent null hypothesis for certain high N situations where the measured data histograms had a wide distribution (Figure 18). These were data sets that the functional form (Equation 8) could not accurately represent, most frequently for low incidence angles in the region $\theta < 20^\circ$. Fortunately, failure of the test was extremely rare (less than 5 occasions in 958).

On the other hand, the modified chi-square test did fail generated distributions that, to the naked eye, appeared acceptable (Figure 18(b)). This is noticeable especially for distributions with $100 \leq N \leq 200$, approximately. Of course, the test is designed to take into account bin height differences between generated and measured histograms the naked eye cannot detect. A list of these distributions is included in the appendix.

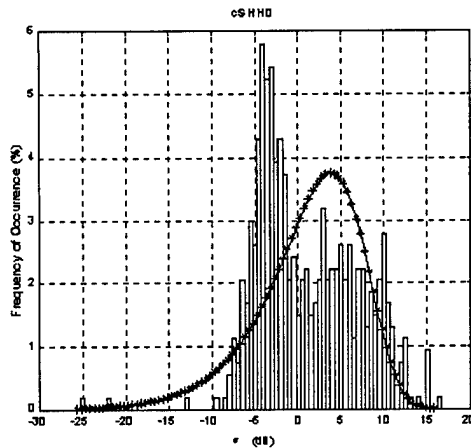


Figure 18(a). Validation Results for Short Vegetation: TS = 87, NTS = 63, $\chi^2 = 65$, N=535

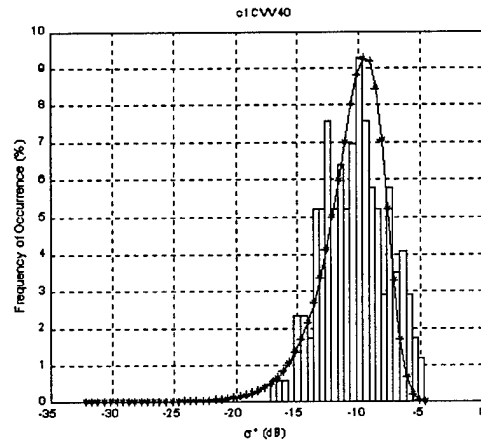


Figure 18(b). Validation Results for Grasses: TS = 115, NTS = 67, $\chi^2 = 34$, N = 172

The observations outlined above serve as an introduction to a more detailed treatment of the results by terrain type. Figures 19 - 27 show graphical output of the generator (dark line) on top of measured data histograms (rectangular bins). The title of each figure describes the terrain type, radar band, polarization, and angle of incidence. For example, aLHH0 means soils and rocks, L band, HH polarization, and $\theta = 0^\circ$. The test statistic, chi-square value, and normalized test statistic values are in the appendix.

Soils and Rocks

In general, this terrain type (type "a") is well documented with N's ranging in the thousands for some cases [8:130]. The main discrepancies between the σ° generator and the measured data were found mostly at low incidence angles ($0^\circ \leq \theta \leq 30^\circ$). Excellent agreement was observed for L, S, and Ku band for $N \geq 100$. C band performance was acceptable (close to 70% success rate) while X band performance was poor (Figures 19(a-i)).

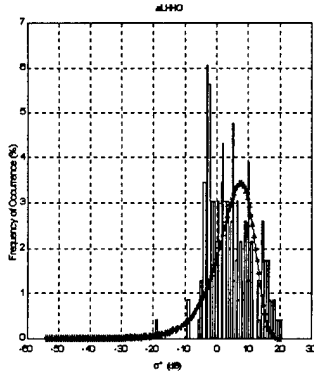


Figure 19 (a) aLHH0

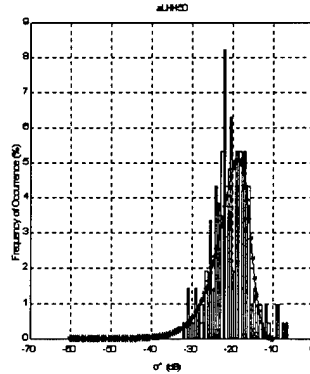


Figure 19 (b) aLHH50

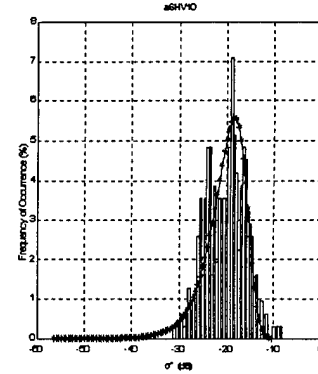


Figure 19 (c) aSHV10

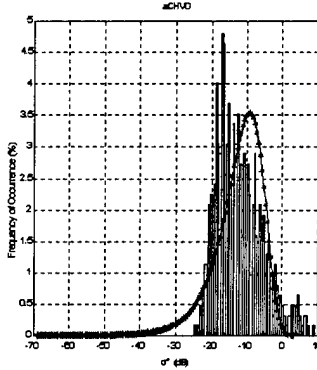


Figure 19 (d) aCHV0

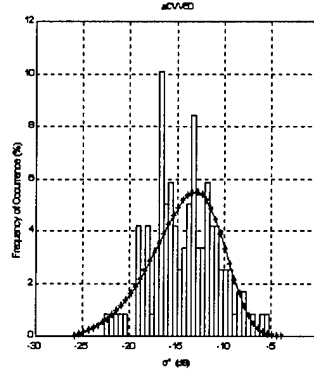


Figure 19 (e) aCVV50

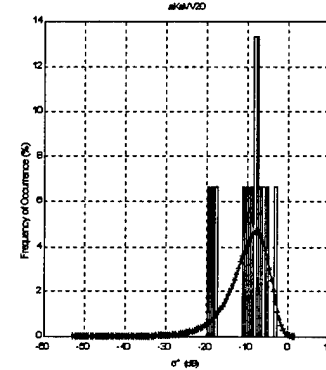


Figure 19 (f) aKaVV20

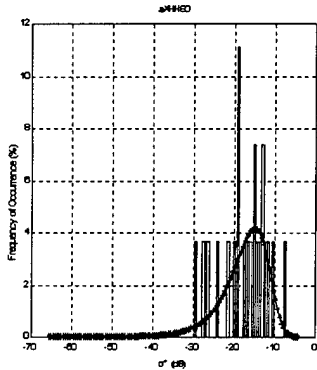


Figure 19 (g) aXHH80

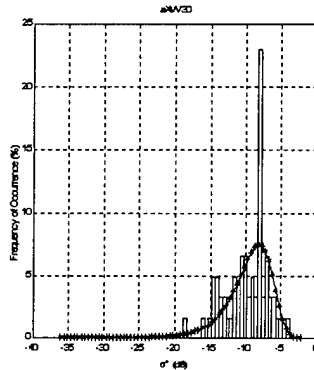


Figure 19 (h) aXVV30

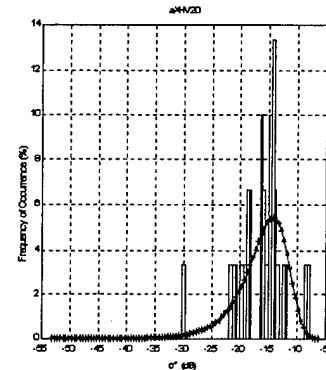


Figure 19 (i) aXHV20

Trees

This category (type "b") was difficult to assess and preliminary validation tests produced high rejection rates. Visual analysis of the data showed three typical situations:

- 1) distribution rejection for low incidence angles,
- 2) rejection due to low number of distribution samples of fair distributions,
- and 3) rejection of fair distributions.

About 97% of all distributions have $N \leq 100$. The generator performance was poor for this

terrain type (Figures 20(a-i)). Special distribution instances, such as bimodal distributions, were noted in this terrain type. Figure 20 (h) illustrates a bimodal distribution with $N = 70$. It is reasonable to suspect that this situation is due to low N .

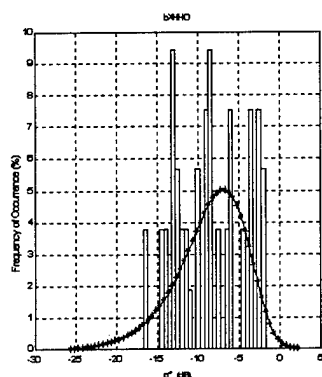


Figure 20 (a) bXHH0

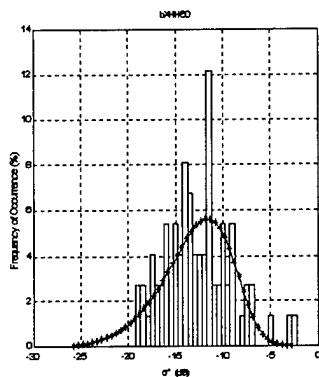


Figure 20 (b) bXHH60

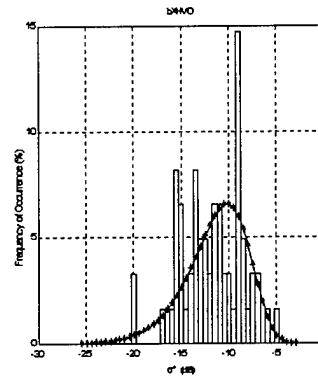


Figure 20 (c) bXHV0

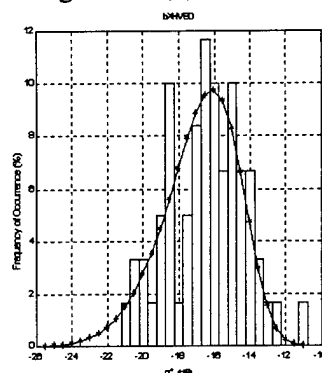


Figure 20 (d) bXHV80

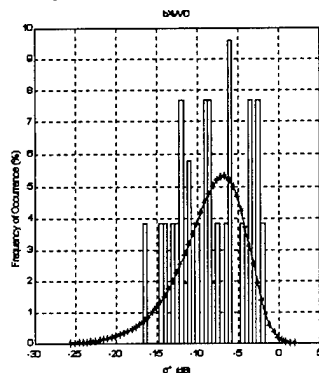


Fig 20 (e) bXVV0

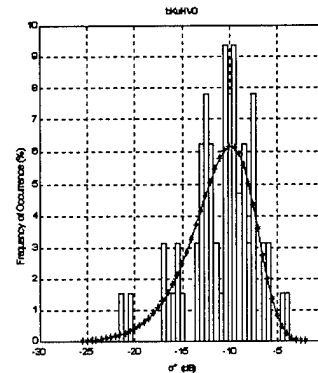


Figure 20 (f) bKuHV0

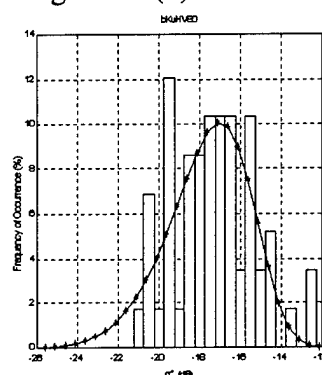


Figure 20 (g) bKuHV60

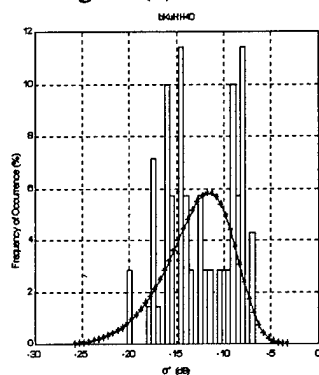


Figure 20 (h) bKuHH40

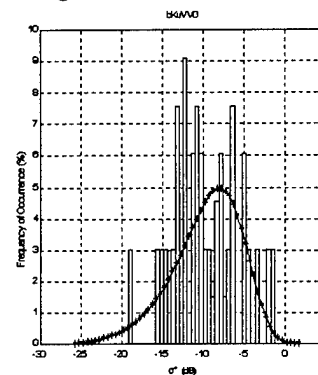


Figure 20 (i) bKuVV0

Grasses

This terrain type (type "c1") featured high N for many data sets. The generator performed well for all radar bands except L band (Figure 21 (a-i)).

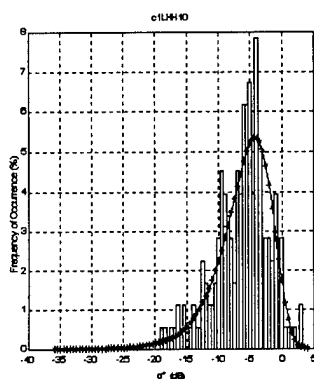


Figure 21 (a) c1LHH10

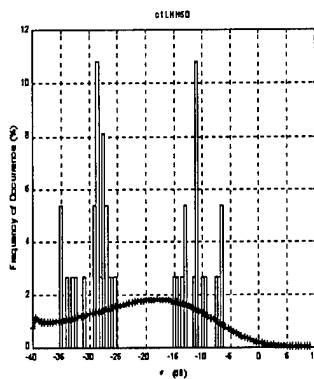


Figure 21 (b) c1LHH50

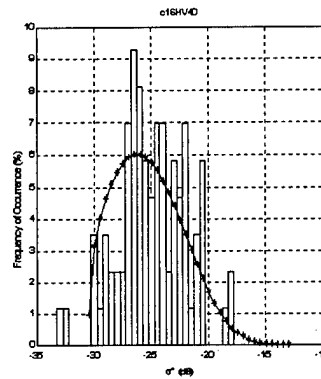


Figure 21 (c) c1SHV40

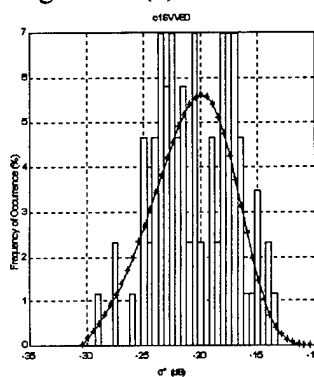


Figure 21 (d) c1SVV60

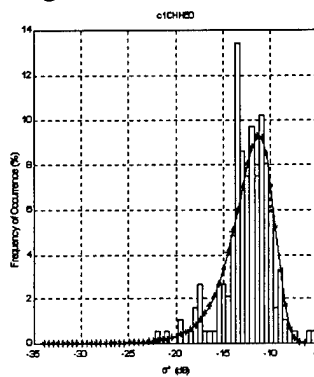


Figure 21 (e) c1CHH60

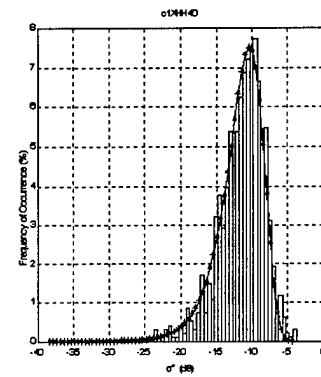


Figure 21 (f) c1XHH40

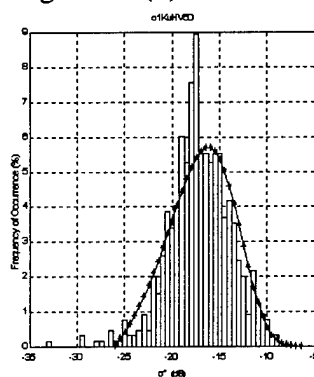


Figure 21 (g) c1KuHV50

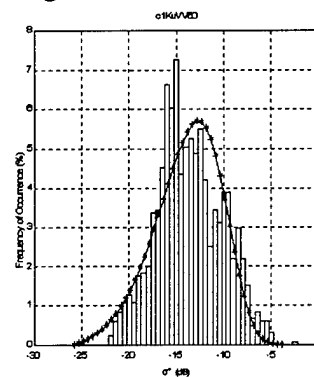


Figure 21 (h) c1KuVV60

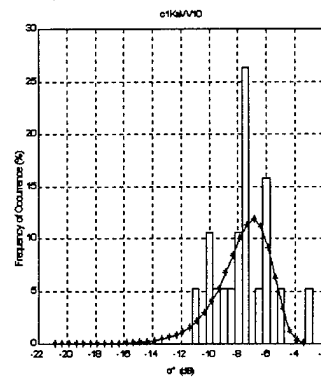


Figure 21 (i) c1KaVV10

Shrubs

The σ^0 generator performed satisfactorily for this terrain type (type "c3") for most incidence angles (Figures 22 (a-i)). Discrepancies were noted in the region $0^\circ \leq \theta \leq 30^\circ$ for all data sets, especially when $100 \leq N \leq 200$. The generator had excellent to acceptable performance for all bands. The average success rate was 65%.

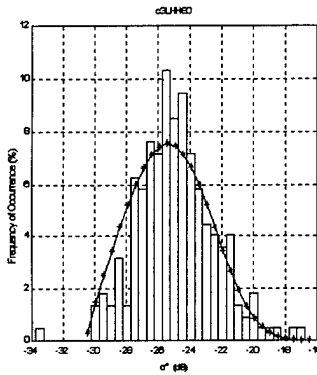


Figure 22 (a) c3LHH80

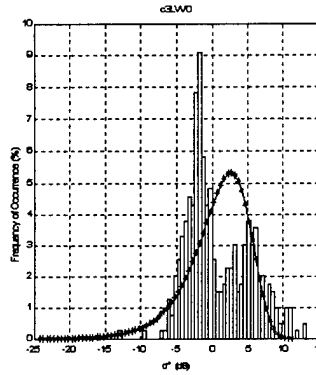


Figure 22 (b) c3LVV0

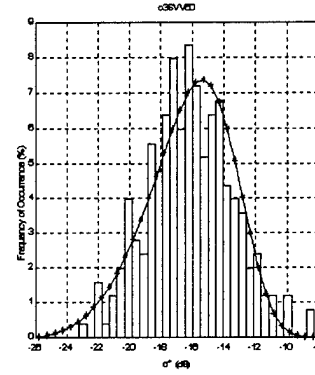


Figure 22 (c) c3SVV60

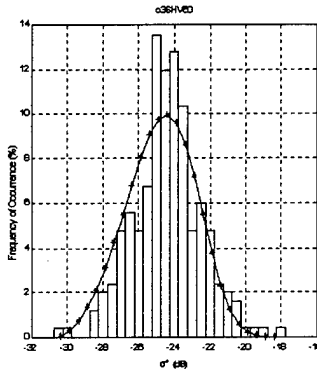


Figure 22 (d) c3SHV60

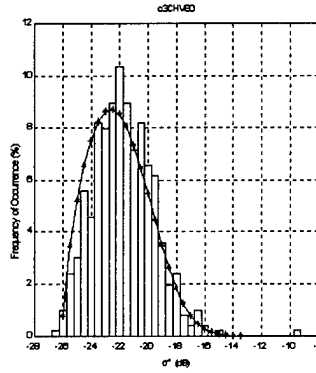


Figure 22 (e) c3CHV60

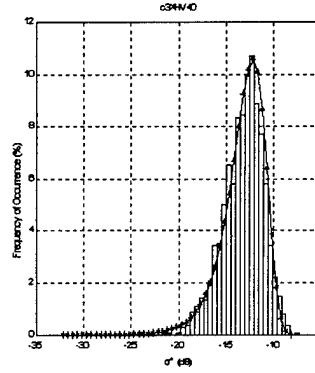


Figure 22 (f) c3XHV40

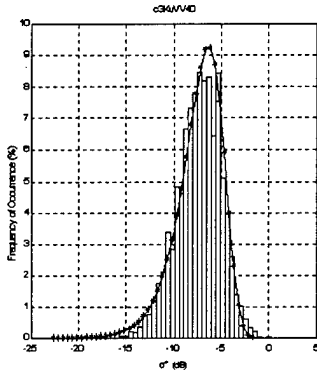


Figure 22 (g) c3KuVV40

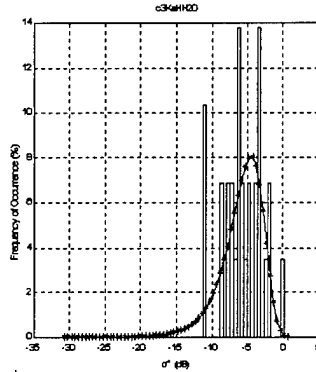


Figure 22 (h) c3KaHH20

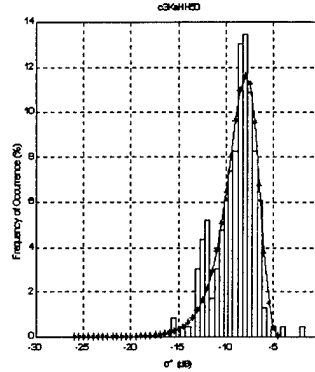


Figure 22 (i) c3KaHH50

Short Vegetation

This terrain type (type "c") featured good agreement for most well documented data sets ($N > 100$) for $\theta \approx 30^\circ$ and above (Figures 23 (a-g)). Average success rate was about 80%. Excellent to good performance for all radar bands. Incidentally, this terrain type features very large N [8:247].

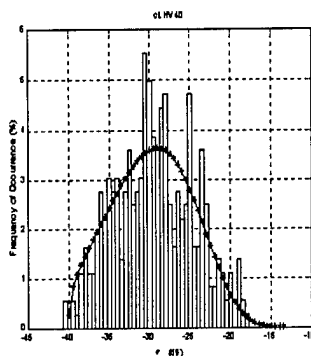


Figure 23 (a) cLHV40

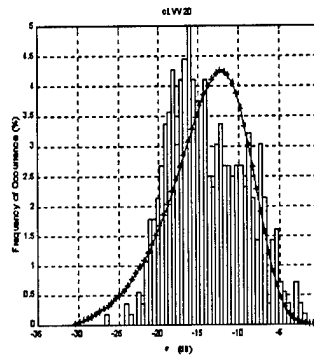


Figure 23(b) cLVV20

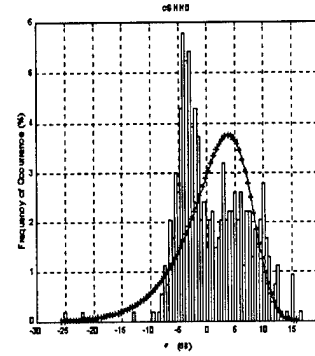


Figure 23(c) cSHH0

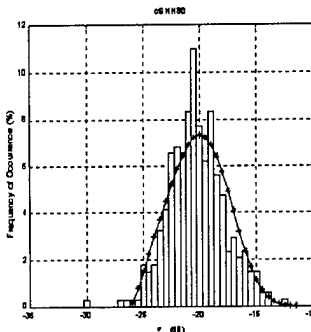


Figure 23 (d) cSHH80

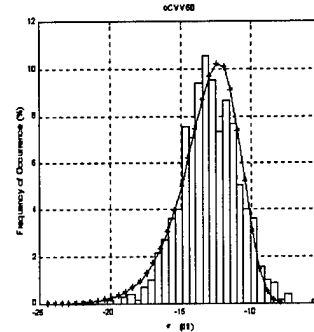


Figure 23 (e) cCVV60

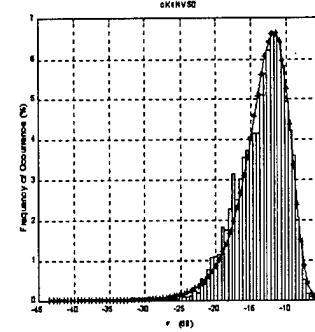


Figure 23 (f) cKaHV50

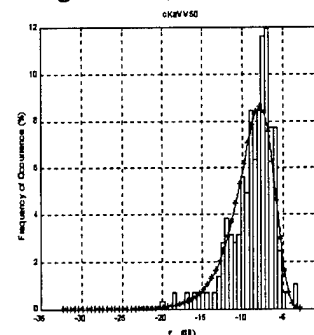


Figure 23 (g) cKaVV50

Roads

This terrain type (type "d") was characterized by $N < 100$ and sparse histograms. Some of the distributions were well suited for description using uniform distributions (Figures 24 (a-c)). Consequently, the generator performance was poor. However, a fair assessment of the modeling capabilities of the σ^0 generator for this terrain type requires a higher N .

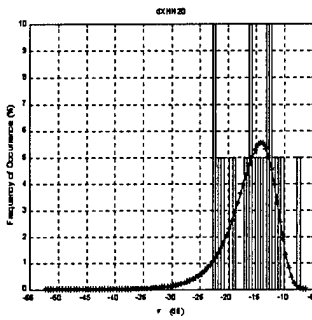


Figure 24 (a) dXHH20

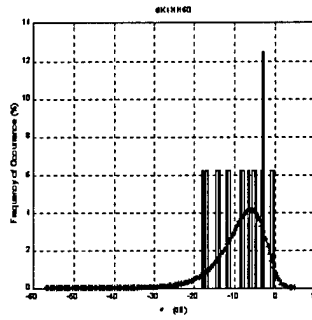


Figure 24 (b) dKuHH60

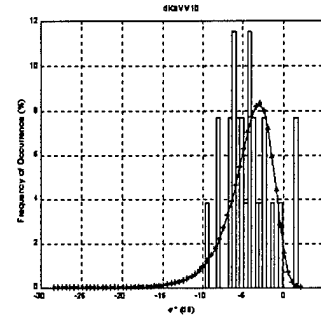


Figure 25 (c) dKaVV10

Dry Snow

For this terrain type (type "f"), the σ^0 generator performance varied from excellent to good for distributions with $N \geq 100$ and L, S, C, and Ku radar bands (Figures 25 (a-i)). The success rate was about 70% for these bands. Also, visual inspection of rejected histograms demonstrated good agreement between the σ^0 generator and measured data (appendix).

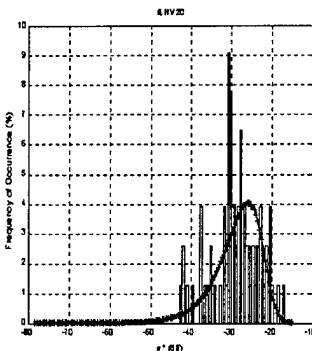


Figure 25 (a) fLHV20

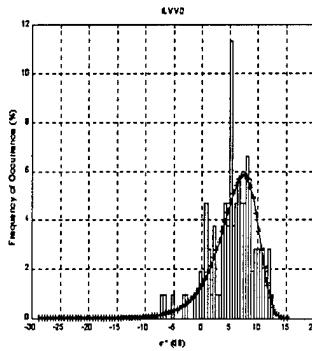


Figure 25 (b) fLVV0

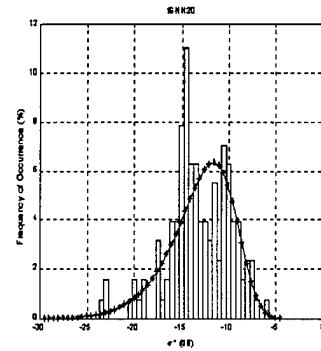


Figure 25 (c) fSHH20

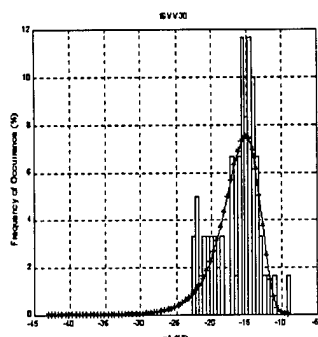


Figure 25 (d) fSVV30

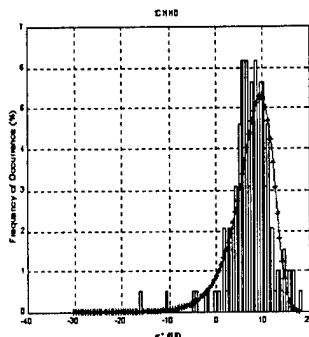


Figure 25 (e) fCHH0

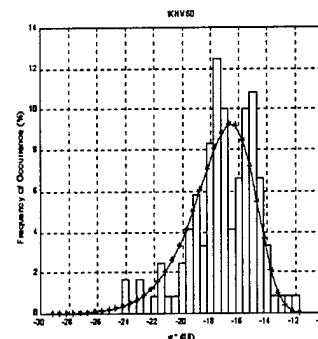


Figure 25 (f) fXHV50

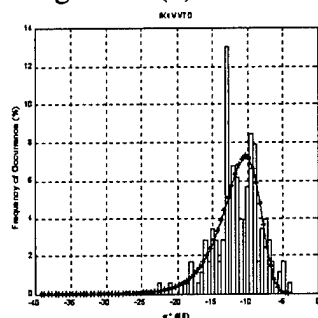


Figure 25 (g) fKuVV70

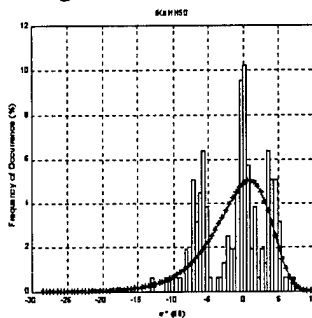


Figure 25 (h) fKaHH50

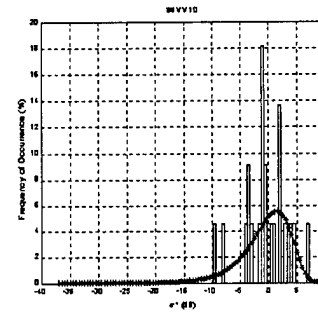


Figure 25 (i) fWVV10

Wet Snow

For wet snow (type "g"), the σ^0 generator functional form yielded good agreement for C, X, Ku, and Ka bands with a success rate of about 75% (Figures 26 (a-i)). Performance was poor for L and S bands at low incidence angles.

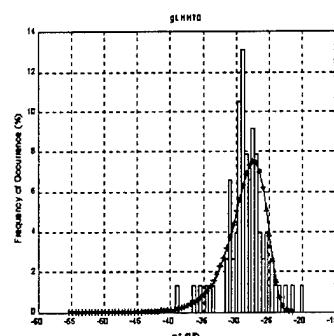


Figure 26 (a) gLHH70

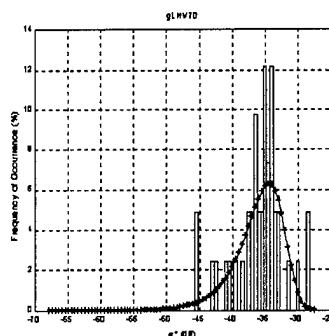


Figure 26 (b) gLHV70

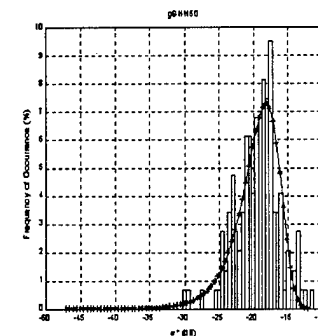


Figure 26 (c) gSHH80

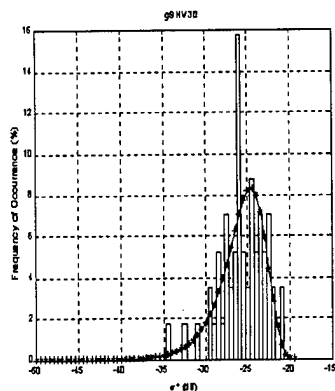


Figure 26 (d) gSHV30

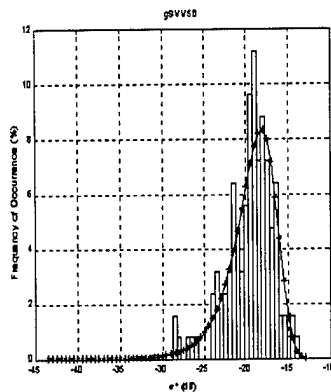


Figure 26 (e) gSVV50

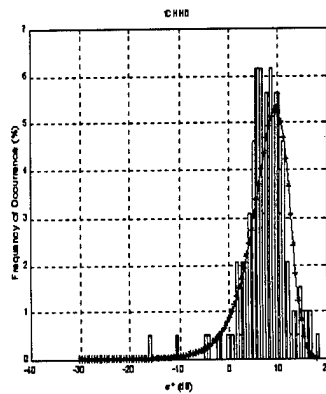


Figure 26 (f) fCHH0

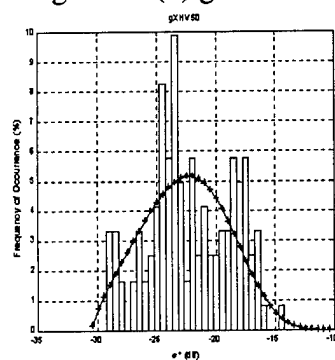


Figure 26 (g) gXHV50

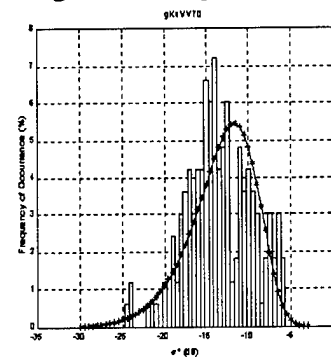


Figure 26 (h) gKuVV70

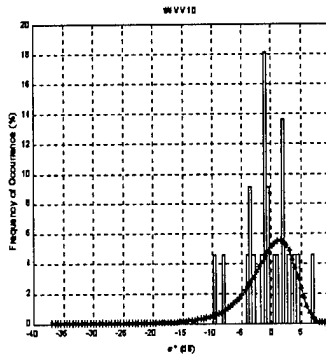


Figure 26 (i) fWVV10

Summary of Results

The experimental results demonstrate the soundness of the σ^0 generator approach. The function in (8) has broad applicability to several terrain types, wave polarization, and incidence angle accounting for an overall success rate of 72% for distributions with source data points (N) greater than or equal to 100. These observations are documented in the appendix.

In general, the σ^0 generator performed well for short vegetation, shrubs, and soils and rocks except in the sector $0^\circ \leq \theta \leq 20^\circ$. The distributions at these incidence angles exhibited strong Rayleigh behavior. For wet snow and dry snow, good agreement could be observed for all incidence angles. Roads and trees have the lowest N of all types; hence, rejection rates were high.

It is difficult to explain why the success rate is not higher based on the limited amount of data and its distribution across terrain types. For instance, the σ^0 generator performed very well for short vegetation and shrubs except for low incidence angles. Incidentally, these terrain types have the highest total N. The opposite occurs for terrain types such as trees and roads (appendix). It would be speculative to assert that as N is increased for all terrain types, the σ^0 generator will perform at least as good as for shrubs and short vegetation. However, it is a possibility given the experimental results.

The modified chi-square test proved to be a proper metric. However, when the normalized test statistic and the chi-square value are commensurate, it is advisable to visually judge the generated and measured histogram likelihood. This is also true when $N \leq 200$, approximately, and when observed data histograms have wide distributions.

V. Conclusions and Recommendations

The functional form in (8) accurately converged to the published mean σ^0 and $s(\theta)$ values for nine terrain types, radar bands, the linear pair of wave polarizations, and incidence angles lower than 80° . Equation (8) was also shown to exhibit the same frequency of occurrence histograms for approximately 72% of measured σ^0 distributions with database-source-points $(N) \geq 100$. Above average results were noted for short vegetation (78%), soils and rocks (75%), and grasses (74%). However, experimental results suggest that an alternate functional form (or modification to the current form) may be necessary to accurately portray short vegetation, soils and rocks, grasses, and shrubs for low incidence angles. This inconsistency was not observed for dry and wet snow where the σ^0 generator performed well for all incidence angles (72% and 69% success rates, respectively). Roads and trees require a higher N in order to establish the σ^0 generator suitability. Terrain type "urban" was not validated since all of its distributions exhibited low N .

A consequence of the variability in N is that within σ^0 data sets that had a high number of failed distribution tests, a success could be found. The converse was also true. This variation affected the reliability of the validation tests. Certainly, data quantity and quality is an important factor to be considered for future work.

The following recommendations are given:

(1) Campaigns to measure σ^0 for several terrain types to avoid the variability in N found within data sets for all incidence angles. This will help to precisely evaluate the σ^0 generator in a "controlled" setting.

(2) Explore alternative functional forms that resemble the behavior of σ^0 curves.

Available statistical software packages can be used for this purpose.

(3) A modification to the functional form to appropriately model the σ^0 from certain terrain types for low incidence angles.

(4) Further refinement of the normalized chi-square test to signal when the computational process achieves the desired σ^0 , $s(\theta)$ values, and frequency of occurrence histogram simultaneously.

Appendix: Simulated Data Sets

This appendix contains the generated data for this research. A summary for all generated and validated distributions is included in page 44. The data set groups included are *udmod0*, *udmod1*, *udmod2*, *udmod3*, and *udmod4a*.

The name of the data set group denotes the data set composition. For example, *udmod0* includes all published data sets whose mean σ^0 values were supported by $N \geq 16$. Hence, zero distributions had $N < 16$. The data set group *udmod4a* is composed of data sets that have four or more incidence angles with $N < 16$.

Each data set table in the appendix has 14 labeled columns:

- | | |
|---|--|
| (1) IA = incidence angle | (8) Gamma = gama parameter |
| (2) Mean = published mean σ^0 value | (9) TstStat = test statistic |
| (3) ResMean = generated mean σ^0 value | (10) OAChi = chi-square value |
| (4) StD = published $s(\theta)$ | (11) NormTS = normalized test
statistic |
| (5) ResStD = generated $s(\theta)$ | (12) N = source data points |
| (6) Alpha = alpha parameter | (13) NTS/OACHI = ratio test for
NormTS |
| (7) Beta = beta parameter | (14) TS/OACHI = ratio test for
TstStat |

A value of -1 in column (10) indicates that the number of histogram bins in a distribution was less than two. Validation tests were not done on distributions with less than two bins.

The following line in the table describes the terrain type and measurement conditions. For instance, ACHH0 denotes terrain type A (also referred as *a*), C-Band, HH polarization, and γ value. The terrain type code in italics is also used in this research, specifically when validating the generated distributions. The following list describes all terrain types, radar bands, and polarizations [8:88]:

- | | |
|------------------------------------|---------------------------------------|
| (1) A, <i>a</i> = soils and rocks | (10) L = 1-2 GHz |
| (2) B, <i>b</i> = trees | (11) S = 2-4 GHz |
| (3) C, <i>c1</i> = grasses | (12) C = 4-8 GHz |
| (4) D, <i>c3</i> = shrubs | (13) X = 8-12 GHz |
| (5) E, <i>c</i> = short vegetation | (14) Ku = 12-18 GHz |
| (6) F, <i>d</i> = roads | (15) Ka = 30-40 GHz |
| (7) G, <i>e</i> = urban | (16) W = 90-100 GHz |
| (8) H, <i>f</i> = dry snow | (17) HH, VV = co-polarized components |
| (9) I, <i>g</i> = wet snow | (18) HV = cross-polarized components |

The summary table gives a bird's eye view of validation results by terrain type and radar band. Validation tests are for normalized and regular chi square tests for two range of samples: 1) $N \geq 16$ and 2) $N \geq 100$. The label GE and LE mean *equal or greater than* and *equal or less than*, respectively.

TYPE	DATA SETS	DISTRIBUTIONS	N GE 16	NTS LE 1	TS LE 1
AL	3	29	29	23	6
AS	3	21	21	15	4
AC	3	28	28	19	2
AX	3	26	23	2	16
AKU	3	20	19	5	14
AKA	2	14	0	0	0
BL	2	9	2	0	2
BC	3	15	1	0	0
BX	3	26	26	6	12
BKU	3	27	27	5	17
BKA	1	6	0	0	0
CL	3	25	25	7	8
CS	3	27	27	16	15
CC	3	21	21	20	4
CX	3	25	25	18	4
CKU	3	22	22	18	0
CKA	2	16	14	3	13
CW	1	5	0	0	5
DL	3	21	21	17	2
DS	3	21	21	13	3
DC	3	24	24	15	1
DX	3	24	24	13	0
DKU	3	22	22	15	0
DKA	2	13	12	2	10
EL	3	21	21	18	1
ES	3	23	23	18	2
EC	2	23	23	18	0
EX	2	18	18	12	0
EKU	3	22	22	16	0
EKA	2	17	16	4	10
FX	3	27	14	0	13
FKU	3	27	14	1	14
FKA	3	25	14	0	11
HL	3	18	18	7	13
HS	3	18	18	7	10
HC	3	18	18	14	7
HX	3	23	19	6	13
HKU	3	23	19	10	6
HKA	3	24	15	0	4
HW	3	16	9	0	8
IL	3	18	18	4	12
IS	3	18	18	9	12
IC	3	18	18	11	7
IX	3	24	21	6	13
IKU	3	18	18	9	2
IKA	3	16	10	0	6
IW	2	16	3	0	3
TOTALS	129	958	821	402	305
TYPE	DATA SETS	DISTRIBUTIONS	N GE 16	NTS LT 1	TS LT 1

N GE 100	NTS LE 1	TS LE 1
28	23	6
16	13	0
28	19	2
3	0	1
5	5	1
0	0	0
2	0	2
1	0	0
0	0	0
0	0	0
16	3	2
12	11	5
21	20	4
24	18	4
22	18	0
0	0	0
0	0	0
21	17	2
21	13	3
24	15	1
24	13	0
22	15	0
2	2	0
21	18	1
22	18	2
23	18	0
18	12	0
22	16	0
2	2	2
0	0	0
0	0	0
0	0	0
4	4	3
10	7	5
18	14	7
4	2	1
12	9	3
2	0	0
0	0	0
3	1	0
4	2	2
14	10	6
5	4	3
12	9	2
1	1	0
0	0	0
489	352	70
N GE 100	NTS LT 1	TS LT 1

Added Histograms (N >= 100)	Total Samples per Terrain Type
aCHH30/20/10	
aCHV50/10	
c1CVV40 (picture) TS=67 CS=34	soils 34291 10%
c1KuHH80	trees 3269 1%
c1KuVV20	grass 43013 12.4%
c1SHH0	shrubs 107959 3%
c1SHV0 (picture) TS=54 CS=47	short veg. 134648 39%
c1SVV30,40	roads 1195 0.3%
c3CHV20	dry snow 11880 3.3%
c3CVV40/50	wet snow 10341 1%
c3XHH40	
c3XHV20	Some "success" rates for N >= 100
c3XVV30/40	short veg. 78%
c3SHH40	soils 75%
c3SVV30/40	grasses 74%
c3KuHH30	dry snow 72%
c3KuVV20	wet snow 69%
c3XHV20	shrubs 66%
c3XHH40	
cSVV40 (picture) TS=52 CS=40	
cSHV60	
cCVV40	
cKuVV20	
fKuHH50	
fKuVV50	
fKaHH50	
fLHV0 (picture)	
fSHV50	
fSVV50,30,20	
fCVV0	
gCHV70	
gCVV70	
gSHH20, 50 (picture) TS=43 CS=41	
gCHV30	
gLHH50	
gLVV50	
Subtracted	
c1CVV10 (picture) TS=77 CS=52	
c1KuHH10	
cCHH0 (picture) TS=57 CS=67	
cSHH0	

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
AL HH0												OACHI	OACHI
0	4.5	4.5	6.8	6.9	0.617	2.393	0	290.6	74.5	125.8	231	1.69	3.90
5	0.4	0.4	4.4	4.5	0.403	1.32	0	193.7	55.8	51.9	373	0.93	3.47
10	-4.2	-4.2	4.8	4.8	0.436	0.792	0	147.6	65.2	26.9	548	0.41	2.26
15	-7.3	-7.3	5.8	5.8	0.526	0.584	0	249.4	72.2	45.4	549	0.63	3.45
20	-9.3	-9.3	6.2	6.3	0.562	0.473	0	300.8	75.6	54.6	551	0.72	3.98
25	-10.4	-10.4	5.5	5.5	0.499	0.402	0	59.3	56.9	41.7	142	0.73	1.04
30	-13.9	-13.9	5.9	5.9	0.535	0.274	0	133.5	67.5	38.3	349	0.57	1.98
35	-13.6	-13.6	5.7	5.7	0.517	0.281	0	75.3	58.1	53.4	141	0.92	1.30
40	-15.4	-15.4	5.1	5.1	0.463	0.222	0	46.3	54.6	31.3	148	0.57	0.85
45	-18.6	-18.6	4.3	4.3	0.39	0.147	0	47.4	48.6	33.6	141	0.69	0.98
50	-20.7	-20.7	4.6	4.6	0.417	0.117	0	120.3	53.4	58.1	207	1.09	2.25

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
AL HV0												OACHI	OACHI
0	-16	-16	5.5	5.5	0.499	0.211	0	164.2	62.8	87.3	188	1.39	2.61
5	-18.3	-18.3	3.2	3.2	0.29	0.144	0	112	43.8	33.5	334	0.76	2.56
10	-23	-23.1	3.6	3.6	0.327	0.085	0	142.5	46.2	40.1	355	0.87	3.08
15	-25.2	-25.2	5	5	0.454	0.071	0	108.6	61.7	29.6	367	0.48	1.76
20	-26	-26	5.2	5.2	0.472	0.066	0	94.4	66.3	23.8	397	0.36	1.42
25	-26.4	-26.4	4	4	0.363	0.059	0	45.8	46.2	31.8	144	0.69	0.99
30	-28.9	-28.9	5.2	5.2	0.472	0.047	0	79.4	60.5	24.7	322	0.41	1.31
35	-27.4	-27.4	4.6	4.6	0.417	0.054	0	48.2	48.6	33.7	143	0.69	0.99
40	-27.9	-27.9	4.2	4.2	0.381	0.05	0	74.8	47.4	50.2	149	1.06	1.58
45	-29.6	-29.6	3.6	3.6	0.327	0.04	0	42.7	42.6	29.7	144	0.70	1.00
50	-31.2	-31.2	4.6	4.6	0.417	0.035	0	49.2	53.4	27.5	179	0.51	0.92

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
AL VV0												OACHI	OACHI
0	4.9	4.9	6.5	6.6	0.59	2.467	0	232.9	73.3	101.2	230	1.38	3.18
5	1.2	1.2	4.4	4.4	0.399	1.444	0	92.1	53.4	40.1	230	0.75	1.72
10	-3.6	-3.6	4.5	4.5	0.408	0.835	0	97.5	58.1	23.8	409	0.41	1.68
15	-7.9	-7.9	5.2	5.2	0.472	0.528	0	65.5	66.3	16.1	406	0.24	0.99
20	-10.4	-10.4	5.4	5.4	0.49	0.4	0	76.4	67.5	18.7	408	0.28	1.13
30	-14.7	-14.7	6.4	6.5	0.581	0.257	0	79.2	66.3	38.7	205	0.58	1.19
50	-19.5	-19.5	4.9	4.9	0.445	0.137	0	43.5	43.8	66.9	65	1.53	0.99

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
AS HH2												OACHI	OACHI
0	2.6	2.6	7.5	7.5	0.708	1.975	0.02	353	73.3	133.7	264	1.82	4.82
5	-0.4	-0.4	5.9	5.9	0.556	1.277	0.02	72.9	62.8	39.2	186	0.62	1.16
10	-3.9	-3.9	4.7	4.7	0.449	0.795	0.02	71.3	58.1	16.1	442	0.28	1.23
15	-6.2	-6.2	4.5	4.5	0.436	0.599	0.02	64.8	59.3	17.9	361	0.30	1.09
20	-9	-9	4.5	4.5	0.448	0.428	0.02	106	59.3	24	442	0.40	1.79
30	-12.2	-12.2	5.1	5.1	0.535	0.299	0.02	151.8	61.7	57.5	264	0.93	2.46
40	-15.8	-15.8	5.7	5.7	0.657	0.196	0.02	40.2	54.6	49.1	82	0.90	0.74
50	-19.2	-19.2	2.2	2.2	0.254	0.103	0.02	11.5	18.3	71.9	16	3.93	0.63

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
AS VV0 OACHI OACHI

0	2.4	2.4	7.5	7.6	0.68	1.95	0	405.5	73.3	153.6	264	2.10	5.53
5	-0.9	-0.9	5.7	5.8	0.518	1.214	0	80.2	60.5	43.1	186	0.71	1.33
10	-4	-4	4.7	4.7	0.426	0.806	0	87.9	60.5	19.9	441	0.33	1.45
15	-6.4	-6.4	4.7	4.7	0.426	0.611	0	72.4	60.5	20	362	0.33	1.20
20	-9	-9	4.6	4.6	0.417	0.451	0	129	61.7	29.2	442	0.47	2.09
30	-12.6	-12.6	5.2	5.2	0.472	0.307	0	265.3	58.1	100.9	263	1.74	4.57
40	-14.2	-14.2	4.9	4.9	0.445	0.252	0	34.2	47.4	41.7	82	0.88	0.72
50	-17.8	-17.8	3	3	0.272	0.151	0	24.2	19.7	151.2	16	7.68	1.23

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
BK UHH5 OACHI OACHI

0	-9.8	-9.8	4.2	4.2	0.49	0.35	0.05	36.5	42.6	55.3	66	1.30	0.86
10	-9.8	-9.8	4.5	4.5	0.53	0.356	0.05	43	43.8	61.5	70	1.40	0.98
20	-10.9	-10.9	4	4	0.481	0.299	0.05	47.2	37.7	73.8	64	1.96	1.25
30	-12.3	-12.3	4.1	4.1	0.523	0.247	0.05	67.8	40.1	104.3	65	2.60	1.69
40	-12.8	-12.8	3.5	3.5	0.446	0.223	0.05	79	37.7	112.8	70	2.99	2.10
50	-13.3	-13.3	2.8	2.8	0.356	0.199	0.05	40.4	28.9	61.2	66	2.12	1.40
60	-14.3	-14.3	2.7	2.7	0.359	0.171	0.05	25.9	30.1	37	70	1.23	0.86
70	-16.7	-16.7	2.6	2.6	0.4	0.116	0.05	21.3	31.4	33.3	64	1.06	0.68
80	-16.2	-16.2	2.6	2.6	0.386	0.126	0.05	29.2	30.1	50.3	58	1.67	0.97

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
BK UHV5 OACHI OACHI

0	-11.2	-11.2	3.4	3.4	0.406	0.277	0.05	21.4	37.7	33.4	64	0.89	0.57
10	-11.4	-11.4	4	4	0.49	0.279	0.05	45.2	38.9	70.7	64	1.82	1.16
20	-12.2	-12.2	3.3	3.3	0.408	0.24	0.05	27	32.7	42.3	64	1.29	0.83
30	-13.2	-13.2	3	3	0.383	0.204	0.05	21.1	35.2	32.9	64	0.93	0.60
40	-14	-14	2.5	2.5	0.325	0.176	0.05	15.4	31.4	24	64	0.76	0.49
50	-14.2	-14.2	2.1	2.1	0.272	0.167	0.05	36.5	26.3	62.9	58	2.39	1.39
60	-15.2	-15.2	2	2	0.272	0.142	0.05	8.4	27.6	13.1	64	0.47	0.30
70	-17.7	-17.7	2.8	2.8	0.476	0.098	0.05	20.9	30.1	36	58	1.20	0.69
80	-17.6	-17.6	2	2	0.322	0.095	0.05	17.9	23.7	30.9	58	1.30	0.76

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
BK UVV5 OACHI OACHI

0	-9.6	-9.6	4.2	4.2	0.487	0.36	0.05	43.2	42.6	65.5	66	1.54	1.01
10	-9.6	-9.6	4.5	4.5	0.527	0.365	0.05	38.3	42.6	54.8	70	1.29	0.90
20	-10.3	-10.3	3.9	3.9	0.459	0.322	0.05	37.3	38.9	54	69	1.39	0.96
30	-11.5	-11.5	4.1	4.1	0.506	0.277	0.05	64.2	38.9	89.2	72	2.29	1.65
40	-12	-12	3.6	3.6	0.446	0.251	0.05	70.1	37.7	87.6	80	2.32	1.86
50	-12.5	-12.5	2.8	2.8	0.344	0.223	0.05	57.2	30.1	74.2	77	2.47	1.90
60	-14	-14	2.5	2.5	0.325	0.176	0.05	27.4	27.6	39.1	70	1.42	0.99
70	-16.4	-16.4	2.7	2.7	0.408	0.123	0.05	16.7	31.4	26.1	64	0.83	0.53
80	-16.1	-16.1	2.6	2.6	0.383	0.128	0.05	27.2	30.1	46.8	58	1.55	0.90

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
BX HV5	OACHI OACHI												
0	-11.4	-11.4	3.2	3.2	0.382	0.267	0.05	34.1	35.2	55.9	59	1.59	0.97
10	-10.9	-10.9	3.5	3.5	0.415	0.29	0.05	30.2	37.7	51.3	59	1.36	0.80
20	-12	-12	2.9	2.9	0.351	0.241	0.05	14.8	32.7	22.8	61	0.70	0.45
30	-13	-13	2.4	2.4	0.297	0.203	0.05	17.6	28.9	26.6	62	0.92	0.61
40	-14.8	-14.8	3.9	3.9	0.563	0.169	0.05	77	40.1	101.4	72	2.53	1.92
60	-15.5	-15.5	2	2	0.276	0.136	0.05	11.1	25	17.1	65	0.68	0.44
70	-16.7	-16.7	2.7	2.7	0.419	0.116	0.05	16.1	32.7	27.3	59	0.83	0.49
80	-16.8	-16.8	2.1	2.1	0.318	0.11	0.05	10.7	26.3	17.8	60	0.68	0.41

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
BX VV5	OACHI OACHI												
0	-8.4	-8.4	4	4	0.447	0.416	0.05	39.2	36.4	75.4	50	2.07	1.08
10	-8	-8	4.3	4.3	0.479	0.446	0.05	29	37.7	57.9	50	1.54	0.77
20	-9.7	-9.7	3.7	3.7	0.425	0.345	0.05	40.9	37.7	71.7	53	1.90	1.08
30	-10.4	-10.4	3.5	3.5	0.408	0.311	0.05	46.5	35.2	81.5	53	2.32	1.32
40	-11.6	-11.6	3.6	3.6	0.439	0.265	0.05	53.1	38.9	83	60	2.13	1.37
50	-13	-13	3.2	3.2	0.407	0.213	0.05	46.6	32.7	61.3	76	1.87	1.43
60	-13.7	-13.7	2.7	2.7	0.349	0.186	0.05	24.4	31.4	39.4	62	1.25	0.78
70	-14.7	-14.7	3.8	3.8	0.542	0.171	0.05	74.2	38.9	134.9	55	3.47	1.91
80	-13.5	-13.5	2.5	2.5	0.317	0.19	0.05	18.3	25	41.7	44	1.67	0.73

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
CC HH0	OACHI OACHI												
0	3.6	3.6	5.6	5.6	0.508	2.027	0	132.1	65.2	47	281	0.72	2.03
10	-2.7	-2.7	5.5	5.5	0.499	0.976	0	103.8	66.3	33.2	313	0.50	1.57
20	-9.1	-9.1	4.7	4.7	0.426	0.448	0	147.2	60.5	50.4	292	0.83	2.43
30	-10.9	-10.9	3.9	3.9	0.354	0.349	0	217	54.6	51.7	420	0.95	3.97
40	-12.9	-12.9	3	3	0.272	0.265	0	44.5	41.3	24.2	184	0.59	1.08
60	-12.4	-12.4	2.5	2.5	0.227	0.273	0	39.8	36.4	21.4	186	0.59	1.09
80	-13.9	-13.9	3	3	0.272	0.236	0	47.2	40.1	27.5	172	0.69	1.18

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
CC HV3	OACHI OACHI												
0	-8.7	-8.7	4.4	4.4	0.456	0.431	0.03	51.4	58.1	19.8	259	0.34	0.88
10	-12.7	-12.7	5.4	5.4	0.624	0.274	0.03	87.5	68.7	32.5	269	0.47	1.27
20	-15.4	-15.4	5.9	5.9	0.762	0.196	0.03	166.9	71	62.5	267	0.88	2.35
30	-17.1	-17.1	5.1	5.1	0.69	0.148	0.03	143.8	65.2	36.4	395	0.56	2.21
40	-17.5	-17.5	3.5	3.5	0.452	0.129	0.03	46.9	47.4	26.3	178	0.55	0.99
60	-18.5	-18.5	2.7	2.7	0.355	0.106	0.03	23.7	38.9	12.9	184	0.33	0.61
80	-21	-21	4	4	0.657	0.077	0.03	71.1	48.6	41.3	172	0.85	1.46

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
CC VV0	OACHI OACHI												
0	3.8	3.8	5.8	5.8	0.526	2.095	0	101.2	67.5	36.1	280	0.53	1.50
10	-1.7	-1.7	5.5	5.5	0.499	1.095	0	85	65.2	30.4	280	0.47	1.30
20	-7.8	-7.8	4.4	4.4	0.399	0.512	0	63.2	56.9	22.6	279	0.40	1.11
30	-10.7	-10.7	3.9	3.9	0.354	0.358	0	123.6	54.6	31.2	396	0.57	2.26
40	-10.6	-10.6	2.5	2.5	0.227	0.336	0	114.6	33.9	66.6	172	1.96	3.38
60	-12.6	-12.6	2.5	2.5	0.227	0.267	0	32.7	35.2	17.8	184	0.51	0.93
80	-15.6	-15.6	3.8	3.8	0.345	0.202	0	65.2	46.2	37.9	172	0.82	1.41

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
CK UHH0												OACHI	OACHI
0	-0.1	-0.1	3.7	3.8	0.339	1.201	0	221.2	48.6	41.7	530	0.86	4.55
10	-3.4	-3.4	4.2	4.2	0.381	0.842	0	508.4	52.2	77.6	655	1.49	9.74
20	-6.6	-6.6	2.7	2.7	0.245	0.538	0	289	46.2	43.5	664	0.94	6.26
30	-8.8	-8.8	2.6	2.6	0.236	0.416	0	157.8	43.8	23.7	666	0.54	3.60
40	-11.5	-11.5	3.1	3.1	0.281	0.313	0	354.4	48.6	26.6	1334	0.55	7.29
50	-12.9	-12.9	3.1	3.1	0.281	0.266	0	276.7	48.6	32.9	841	0.68	5.69
60	-13.1	-13.1	2.6	2.6	0.236	0.253	0	236.6	40.1	17.9	1325	0.45	5.90
70	-14	-14	2.6	2.6	0.236	0.228	0	203.1	36.4	26.6	764	0.73	5.58
80	-15.3	-15.3	2.1	2.1	0.191	0.192	0	231.4	36.4	46	503	1.26	6.36

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
CK UVV5												OACHI	OACHI
0	0.8	0.8	4	4	0.388	1.299	0.05	175.5	54.6	33	531	0.60	3.21
10	-3.3	-3.3	4	4	0.406	0.791	0.05	443.7	51	67.5	657	1.32	8.70
20	-7.6	-7.6	2.9	2.9	0.31	0.434	0.05	492.8	48.6	73.8	668	1.52	10.14
30	-10.2	-10.2	3	3	0.343	0.31	0.05	187.1	47.4	27.8	672	0.59	3.95
40	-13.2	-13.2	3.7	3.7	0.485	0.212	0.05	129.6	54.6	9.7	1339	0.18	2.37
50	-14.6	-14.6	3.7	3.7	0.522	0.173	0.05	154.4	51	18.2	849	0.36	3.03
60	-13.9	-13.9	3.5	3.5	0.471	0.19	0.05	252.2	47.4	19.2	1311	0.41	5.32
70	-14.1	-14.1	3.6	3.6	0.492	0.185	0.05	137.9	47.4	18	767	0.38	2.91
80	-13.7	-13.7	2.4	2.4	0.307	0.183	0.05	137.8	40.1	26.9	512	0.67	3.44

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
CL HH1												OACHI	OACHI
0	8.1	8.1	5.2	5.2	0.475	3.322	0.01	46.9	54.6	33.3	141	0.61	0.86
5	1.8	1.8	5.5	5.5	0.507	1.629	0.01	42.1	47.4	71.3	59	1.50	0.89
10	-6.1	-6.1	4.3	4.3	0.403	0.61	0.01	33	52.2	18.5	178	0.35	0.63
15	-11.6	-11.6	4.4	4.4	0.424	0.321	0.01	64.3	40.1	109	59	2.72	1.60
20	-15.6	-15.6	5.5	5.5	0.559	0.211	0.01	129.1	59.3	75.9	170	1.28	2.18
30	-19.3	-19.3	5.7	5.7	0.618	0.135	0.01	130.4	58.1	78.5	166	1.35	2.24
40	-21.2	-21.2	6.1	6.1	0.698	0.109	0.01	109.3	61.7	96.7	113	1.57	1.77
50	-21.1	-21.1	9.8	9.8	1.263	0.131	0.01	64.5	37.7	174.2	37	4.62	1.71
60	-24	-24	5.8	5.8	0.719	0.074	0.01	110.8	59.3	105.5	105	1.78	1.87
80	-29.3	-29.3	3.1	3.1	0.444	0.03	0.01	17.2	37.7	20.1	86	0.53	0.46

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
CL HV0												OACHI	OACHI
0	-14.2	-14.2	4.7	4.7	0.426	0.249	0	90.3	47.4	86.8	104	1.83	1.91
10	-22.4	-22.4	4.2	4.2	0.381	0.094	0	99.5	47.4	80.2	124	1.69	2.10
20	-29.9	-29.9	4.8	4.8	0.435	0.041	0	131.7	49.8	108	122	2.17	2.64
30	-31.4	-31.4	5.1	5.1	0.463	0.035	0	78.2	51	64.1	122	1.26	1.53
40	-33.8	-33.8	3.8	3.8	0.345	0.025	0	33.1	38.9	36	92	0.93	0.85
60	-36	-36	3.5	3.5	0.318	0.019	0	37.1	37.7	43.1	86	1.14	0.98
80	-37.6	-37.6	3.7	3.7	0.336	0.016	0	32	41.3	37.2	86	0.90	0.77

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
CL VV0 OACHI OACHI

0	8	8	5.7	5.7	0.517	3.381	0	70.8	59.3	50.2	141	0.85	1.19
10	-5.2	-5.2	3.7	3.7	0.336	0.667	0	66.1	43.8	46.9	141	1.07	1.51
20	-15	-15	5	5	0.454	0.231	0	153.8	53.4	94.9	162	1.78	2.88
30	-18.6	-18.6	5.8	5.8	0.526	0.159	0	231.4	55.8	142.8	162	2.56	4.15
40	-21.6	-21.6	6.7	6.8	0.608	0.118	0	179.3	60.5	170.7	105	2.82	2.96
50	-23.7	-23.7	6.9	6.9	0.622	0.093	0	125.6	27.6	433.2	29	15.70	4.55
60	-25.1	-25.2	6.1	6.1	0.553	0.076	0	225	54.6	212.2	106	3.89	4.12
80	-27.7	-27.7	2.9	2.9	0.263	0.048	0	22.5	35.2	26.2	86	0.74	0.64

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
CS HH3 OACHI OACHI

0	5.7	5.7	6.4	6.4	0.601	2.661	0.03	87	65.2	63.1	138	0.97	1.33
5	1.7	1.7	5.7	5.7	0.544	1.604	0.03	68.2	43.8	148.2	46	3.38	1.56
10	-5.2	-5.2	4.7	4.7	0.467	0.671	0.03	52.1	54.6	38	137	0.70	0.95
15	-10	-10	4.3	4.3	0.454	0.364	0.03	42.7	40.1	92.8	46	2.31	1.06
20	-12.8	-12.8	4.2	4.2	0.471	0.254	0.03	63.4	49.8	45.9	138	0.92	1.27
30	-15.9	-15.9	3.6	3.6	0.437	0.162	0.03	57.1	42.6	41.4	138	0.97	1.34
40	-16.7	-16.7	3.3	3.3	0.409	0.142	0.03	18.4	36.4	21.4	86	0.59	0.51
60	-18.4	-18.4	3.4	3.4	0.457	0.112	0.03	36.5	40.1	42.4	86	1.06	0.91
80	-20.2	-20.2	3.5	3.5	0.528	0.085	0.03	36.2	41.3	42.1	86	1.02	0.88

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
CS HV3 OACHI OACHI

0	-12.4	-12.4	4	4	0.442	0.264	0.03	66.3	47.4	54.3	122	1.15	1.40
5	-15.1	-15.1	4.1	4.2	0.497	0.187	0.03	24.8	31.4	92	27	2.93	0.79
10	-19.4	-19.4	4.4	4.4	0.658	0.101	0.03	43.1	52.2	33.2	130	0.64	0.83
15	-21.9	-21.9	4.5	4.6	0.842	0.066	0.03	27.2	40.1	69.8	39	1.74	0.68
20	-23	-23	4.5	4.5	0.936	0.053	0.03	41.4	49.8	31.4	132	0.63	0.83
30	-24.2	-24.2	3.8	3.8	0.884	0.04	0.03	53.7	42.6	40.7	132	0.96	1.26
40	-25.2	-25.2	3	3	0.769	0.031	0.03	25.2	35.2	29.3	86	0.83	0.72
60	-27.4	-27.4	3	3	1.348	0.013	0.03	54.5	28.9	63.4	86	2.19	1.89
80	-27.7	-27.7	3.4	3.4	1.725	0.01	0.03	39.6	32.7	46.1	86	1.41	1.21

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
CS VV3 OACHI OACHI

0	5.8	5.8	6.6	6.6	0.62	2.72	0.03	92.8	67.5	67.2	138	1.00	1.37
5	2.1	2.1	5.9	5.9	0.562	1.695	0.03	66.6	43.8	144.7	46	3.30	1.52
10	-4.4	-4.4	4.9	4.9	0.484	0.747	0.03	40.5	55.8	29.4	138	0.53	0.73
15	-9.1	-9.1	4.5	4.6	0.475	0.415	0.03	38	40.1	82.6	46	2.06	0.95
20	-12	-12	4.5	4.5	0.498	0.286	0.03	36.3	52.2	26.5	137	0.51	0.70
30	-15.7	-15.7	3.8	3.8	0.46	0.169	0.03	51.4	42.6	37.3	138	0.88	1.21
40	-17.3	-17.3	3.2	3.2	0.405	0.13	0.03	24.8	35.2	28.9	86	0.82	0.70
60	-19.4	-19.4	3.2	3.2	0.452	0.095	0.03	30.6	38.9	35.6	86	0.92	0.79
80	-20.7	-20.7	3.4	3.4	0.529	0.078	0.03	29	40.1	33.8	86	0.84	0.72

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
CX HH0 OACHI OACHI

0	0.8	0.8	4.4	4.4	0.399	1.379	0	54.4	55.8	22.9	238	0.41	0.97
10	-1.8	-1.8	4.8	4.8	0.436	1.044	0	422.1	62.8	122.3	345	1.95	6.72
20	-6.3	-6.3	3.1	3.1	0.281	0.569	0	375.3	47.4	99.6	377	2.10	7.92
30	-8.8	-8.8	2.6	2.6	0.236	0.416	0	141.5	41.3	27.4	516	0.66	3.43
40	-11.7	-11.7	3.1	3.1	0.281	0.306	0	130.6	51	14	931	0.27	2.56
45	-12.5	-12.5	3.2	3.2	0.289	0.28	0	60.1	25	146.6	41	5.86	2.40
50	-12.8	-12.8	3.1	3.1	0.281	0.269	0	68.8	48.6	7.7	890	0.16	1.42
60	-13.2	-13.2	2.8	2.8	0.254	0.253	0	218.1	48.6	21.1	1033	0.43	4.49
70	-14.7	-14.7	3.1	3.1	0.281	0.216	0	215.3	51	29.6	728	0.58	4.22
80	-15.5	-15.5	3.5	3.5	0.317	0.201	0	192.8	47.4	79.7	242	1.68	4.07

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
CX VV5 OACHI OACHI

0	1.2	1.2	4.4	4.4	0.428	1.393	0.05	70	56.9	29.5	237	0.52	1.23
10	-2.5	-2.5	5	5	0.51	0.921	0.05	396.1	59.3	115.5	343	1.95	6.68
20	-7.7	-7.7	3.1	3.1	0.334	0.433	0.05	393	46.2	84.3	466	1.82	8.51
30	-11.1	-11.1	2.8	2.8	0.327	0.271	0.05	154.3	38.9	30.3	510	0.78	3.97
40	-14.2	-14.2	3.6	3.6	0.495	0.182	0.05	104.2	54.6	11.2	928	0.21	1.91
50	-13.8	-13.8	3.8	3.8	0.515	0.196	0.05	87	52.2	6.4	1366	0.12	1.67
60	-14.5	-14.5	3.5	3.5	0.487	0.173	0.05	109.9	49.8	11.2	979	0.22	2.21
70	-14.8	-14.8	3.7	3.7	0.529	0.167	0.05	69.2	53.4	9.5	729	0.18	1.30
80	-14.6	-14.6	3.8	3.8	0.538	0.174	0.05	207.5	49.8	87.9	236	1.77	4.17

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
DC HH5 OACHI OACHI

0	-0.9	-0.9	4.7	4.8	0.471	1.102	0.05	1419.8	52.2	176.4	805	3.38	27.20
10	-3.7	-3.7	4.3	4.3	0.441	0.766	0.05	244.9	60.5	20.8	1176	0.34	4.05
20	-8.1	-8.1	3.3	3.3	0.36	0.416	0.05	396.8	48.6	38.2	1040	0.79	8.16
30	-9.7	-9.7	3.1	3.1	0.35	0.334	0.05	462.9	51	49.3	939	0.97	9.08
40	-12	-12	2.4	2.4	0.286	0.234	0.05	161.8	33.9	29.3	553	0.86	4.77
50	-13	-13	2.9	2.9	0.365	0.209	0.05	79.2	46.2	12.3	643	0.27	1.71
60	-13.8	-13.8	1.9	1.9	0.24	0.175	0.05	80.4	28.9	15.3	524	0.53	2.78
80	-18	-18	1.8	1.8	0.297	0.087	0.05	54.7	31.4	10.8	505	0.34	1.74

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
DC HV5 OACHI OACHI

0	-12.5	-12.5	4.8	4.8	0.636	0.249	0.05	578.8	54.6	79	733	1.45	10.60
10	-14.6	-14.6	3.8	3.8	0.538	0.174	0.05	637.5	49.8	77.4	824	1.55	12.80
20	-16	-16	3.4	3.4	0.519	0.136	0.05	603.6	52.2	60.8	993	1.16	11.56
30	-16.5	-16.5	3.4	3.4	0.539	0.125	0.05	344.6	49.8	38.9	886	0.78	6.92
40	-17.7	-17.7	2.3	2.3	0.38	0.095	0.05	49.7	33.9	9.1	549	0.27	1.47
50	-18.1	-18.1	3.4	3.4	0.624	0.094	0.05	208.1	47.4	32.6	638	0.69	4.39
60	-18.5	-18.5	1.9	1.9	0.33	0.08	0.05	77.1	30.1	14.8	520	0.49	2.56
80	-22	-22	2.1	2.1	0.651	0.035	0.05	31.3	32.7	6.2	503	0.19	0.96

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
DK UHH5 OACHI OACHI

0	-1.8	-1.8	5.2	5.2	0.527	1.014	0.05	1531.1	54.6	206.3	742	3.78	28.04
10	-1.5	-1.5	5.7	5.7	0.58	1.08	0.05	3012.2	72.2	232.1	1298	3.21	41.72
20	-4.9	-4.9	3.1	3.1	0.318	0.618	0.05	1449.5	43.8	111.2	1303	2.54	33.09
30	-6.2	-6.2	2.2	2.2	0.227	0.499	0.05	581.8	41.3	44.6	1304	1.08	14.09
40	-7.6	-7.6	2.2	2.2	0.233	0.417	0.05	486.9	37.7	16.3	2985	0.43	12.92
50	-8.4	-8.4	2.2	2.2	0.236	0.376	0.05	801	35.2	29.5	2715	0.84	22.76
60	-9.5	-9.5	2.4	2.4	0.266	0.329	0.05	547.6	38.9	18.3	2991	0.47	14.08
70	-11.2	-11.2	2.2	2.2	0.254	0.258	0.05	113.8	37.7	5.1	2231	0.14	3.02
80	-14.4	-14.4	2	2	0.26	0.161	0.05	90.8	31.4	13.2	687	0.42	2.89

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
DK UHV0 OACHI OACHI

40	-11.1	-11.1	2.3	2.3	0.209	0.314	0	465.9	33.9	27.4	1702	0.81	13.74
50	-11.9	-11.9	2.4	2.4	0.218	0.288	0	105	45	6.1	1715	0.14	2.33
60	-12.9	-12.9	2.3	2.3	0.209	0.255	0	417.9	36.4	24.9	1677	0.68	11.48
70	-14.8	-14.8	2.2	2.2	0.2	0.204	0	241.3	36.4	15.6	1549	0.43	6.63

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
DK UVV5 OACHI OACHI

0	-1	-1	5.1	5.1	0.513	1.112	0.05	1920.4	58.1	257.8	745	4.44	33.05
10	-1.3	-1.3	5.3	5.3	0.535	1.083	0.05	3736.4	67.5	277.2	1348	4.11	55.35
20	-4.5	-4.5	3	3	0.305	0.646	0.05	788.3	47.4	58.3	1353	1.23	16.63
30	-5.8	-5.8	2.3	2.3	0.236	0.528	0.05	294.4	43.8	21.7	1354	0.50	6.72
40	-7.4	-7.4	2.4	2.4	0.254	0.433	0.05	367	41.3	12.1	3034	0.29	8.89
50	-8.4	-8.4	2.4	2.4	0.259	0.38	0.05	376.4	42.6	13.6	2763	0.32	8.84
60	-9.6	-9.6	2.5	2.5	0.278	0.326	0.05	989.5	40.1	33	2995	0.82	24.68
70	-11.5	-11.5	2.4	2.4	0.281	0.251	0.05	547.2	38.9	24.4	2240	0.63	14.07
80	-14.1	-14.1	2.1	2.1	0.271	0.169	0.05	246.5	37.7	36.5	676	0.97	6.54

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
DL HH3 OACHI OACHI

0	1.3	1.3	5.1	5.1	0.485	1.485	0.03	436.2	60.5	110.2	396	1.82	7.21
10	-7.5	-7.5	5.5	5.5	0.57	0.53	0.03	162.9	60.5	38.1	427	0.63	2.69
20	-12.5	-12.5	6.7	6.7	0.801	0.301	0.03	202.7	72.2	46	441	0.64	2.81
30	-15	-15	6.5	6.5	0.845	0.213	0.03	146.2	71	33.2	440	0.47	2.06
40	-19.4	-19.4	5.7	5.7	0.909	0.107	0.03	145.7	61.7	52.2	279	0.85	2.36
60	-23.8	-23.8	4.5	4.5	1.041	0.044	0.03	138.9	52.2	57.4	242	1.10	2.66
80	-25.3	-25.3	2.4	2.4	0.592	0.03	0.03	24.9	33.9	11.2	223	0.33	0.73

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
DL HV1 OACHI OACHI

0	-22.9	-22.9	3.6	3.6	0.403	0.076	0.01	249.4	43.8	102.2	244	2.33	5.69
10	-24.1	-24.1	4.8	4.8	0.578	0.069	0.01	133.9	53.4	38.1	351	0.71	2.51
20	-24.8	-24.8	5.7	5.7	0.726	0.066	0.01	119.1	64	31.5	378	0.49	1.86
30	-25.4	-25.4	5.5	5.5	0.714	0.06	0.01	80.6	59.3	21.3	378	0.36	1.36
40	-28.4	-28.4	4.4	4.4	0.633	0.037	0.01	70	54.6	26	269	0.48	1.28
60	-31	-31	3.5	3.5	0.582	0.023	0.01	51.6	45	23.2	223	0.52	1.15
80	-32.7	-32.7	2.6	2.6	0.485	0.016	0.01	38.3	37.7	17.3	221	0.46	1.02

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OAChi	NormTS	N	NTS/	TS/
DS HH5	OACHI OACHI												
0	-0.2	-0.2	4.8	4.9	0.479	1.206	0.05	466.4	60.5	117.5	397	1.94	7.71
10	-7.2	-7.2	4.2	4.2	0.458	0.491	0.05	113.3	51	28.5	397	0.56	2.22
20	-11.7	-11.7	3.5	3.5	0.427	0.26	0.05	106	45	26.7	397	0.59	2.36
30	-13.5	-13.5	3.2	3.2	0.417	0.198	0.05	90.2	48.6	22.7	386	0.47	1.86
40	-16.7	-16.7	2.4	2.4	0.367	0.114	0.05	87.2	33.9	34.8	251	1.03	2.57
60	-18.5	-18.5	2.3	2.3	0.41	0.082	0.05	30.6	33.9	12.2	251	0.36	0.90
80	-20	-20	2	2	0.421	0.059	0.05	18.8	30.1	7.5	251	0.25	0.62

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OAChi	NormTS	N	NTS/	TS/
DS HV3	OACHI OACHI												
0	-18.8	-18.8	4	4	0.565	0.109	0.03	233.8	47.4	74.2	315	1.57	4.93
10	-20.1	-20.1	3.7	3.7	0.558	0.088	0.03	105.6	48.6	27	391	0.56	2.17
20	-21	-21	3.3	3.3	0.522	0.074	0.03	126.9	47.4	32.5	391	0.69	2.68
30	-21.4	-21.4	3	3	0.482	0.068	0.03	77.1	38.9	20	386	0.51	1.98
40	-23.4	-23.4	2.3	2.3	0.432	0.045	0.03	42	32.7	16.7	251	0.51	1.28
60	-24.8	-24.8	1.9	1.9	0.414	0.033	0.03	32.3	28.9	12.9	251	0.45	1.12
80	-27.9	-27.9	1.8	1.8	0.838	0.012	0.03	121.6	26.3	48.5	251	1.84	4.62

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OAChi	NormTS	N	NTS/	TS/
DS VV5	OACHI OACHI												
0	-0.3	-0.3	4.9	5	0.49	1.198	0.05	352.5	59.3	89.2	395	1.50	5.94
10	-6.8	-6.8	4	4	0.43	0.511	0.05	207	49.8	52.1	397	1.05	4.16
20	-11.6	-11.6	2.9	2.9	0.346	0.255	0.05	176.9	46.2	44.6	397	0.97	3.83
30	-13.3	-13.3	2.5	2.5	0.315	0.195	0.05	208.7	38.9	52.8	395	1.36	5.37
40	-15	-15	2.7	2.7	0.373	0.153	0.05	123.9	36.4	49.3	251	1.35	3.40
60	-16.2	-16.2	2.7	2.7	0.404	0.126	0.05	26.5	38.9	10.6	251	0.27	0.68
80	-19.2	-19.2	2.6	2.6	0.512	0.073	0.05	72.2	35.2	28.8	251	0.82	2.05

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OAChi	NormTS	N	NTS/	TS/
DX HH3	OACHI OACHI												
0	-2.9	-2.9	5.3	5.3	0.519	0.913	0.03	1105.4	53.4	182.4	606	3.42	20.70
10	-2.1	-2.1	6.1	6.1	0.599	1.048	0.03	3125.6	60.5	290.8	1075	4.81	51.66
20	-6	-6	3.1	3.1	0.305	0.559	0.03	1096	37.7	98.6	1111	2.62	29.07
30	-7.3	-7.3	2.3	2.3	0.228	0.456	0.03	790.9	37.7	65.8	1202	1.75	20.98
40	-9.2	-9.2	2.1	2.1	0.212	0.357	0.03	1791.6	36.4	71	2523	1.95	49.22
50	-10.4	-10.4	2.5	2.5	0.258	0.314	0.03	331.7	48.6	12.9	2569	0.27	6.83
60	-11.2	-11.2	2.5	2.5	0.262	0.283	0.03	905	38.9	34.6	2616	0.89	23.26
70	-13.2	-13.2	2.4	2.4	0.261	0.217	0.03	310.7	41.3	16.1	1930	0.39	7.52
80	-15.7	-15.7	1.6	1.6	0.183	0.148	0.03	103.3	27.6	17.1	605	0.62	3.74

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OAChi	NormTS	N	NTS/	TS/
DX VV5	OACHI OACHI												
0	-2.7	-2.7	5.2	5.2	0.534	0.909	0.05	786.3	53.4	128.9	610	2.41	14.72
10	-2.2	-2.2	6	6	0.619	1.008	0.05	2872.5	61.7	267.5	1074	4.34	46.56
20	-6	-6	3	3	0.312	0.535	0.05	1275.4	42.6	105.7	1207	2.48	29.94
30	-7.5	-7.5	2.2	2.2	0.232	0.422	0.05	609.6	41.3	50.9	1198	1.23	14.76
40	-9.2	-9.2	2.1	2.1	0.229	0.336	0.05	1402.5	40.1	55.6	2521	1.39	34.98
50	-9.7	-9.7	2.8	2.8	0.314	0.328	0.05	171.1	48.6	4.6	3684	0.09	3.52
60	-11.5	-11.5	2.2	2.2	0.257	0.248	0.05	312.7	36.4	12.2	2565	0.34	8.59
70	-13.3	-13.3	2.4	2.4	0.301	0.194	0.05	298.2	41.3	15.5	1929	0.38	7.22
80	-16.6	-16.6	1.7	1.7	0.249	0.111	0.05	83.4	28.9	13.9	601	0.48	2.89

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
EC	HH3											OACHI	OACHI
0	0.3	0.3	6.2	6.2	0.596	1.398	0.03	627.9	67.5	57.8	1086	0.86	9.30
10	-3.5	-3.5	4.6	4.6	0.45	0.819	0.03	437.6	67.5	29.4	1489	0.44	6.48
20	-8.3	-8.3	3.7	3.7	0.377	0.436	0.03	382.1	61.7	28.7	1332	0.47	6.19
30	-10.1	-10.1	3.4	3.4	0.354	0.343	0.03	639.1	56.9	47	1359	0.83	11.23
40	-12.2	-12.2	2.6	2.6	0.278	0.251	0.03	102.4	43.8	13.9	737	0.32	2.34
50	-14	-14	3.3	3.3	0.373	0.206	0.03	120.2	54.6	12.2	986	0.22	2.20
60	-13.4	-13.4	2.2	2.2	0.239	0.21	0.03	126.4	37.7	17.8	710	0.47	3.35
80	-17	-17	2.8	2.8	0.345	0.133	0.03	470.9	45	69.6	677	1.55	10.46

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
EC	HV5											OACHI	OACHI
0	-11.5	-11.5	5	5	0.638	0.29	0.05	304.4	64	30.7	992	0.48	4.76
10	-14.1	-14.1	4.3	4.3	0.606	0.192	0.05	385.7	61.7	35.3	1093	0.57	6.25
20	-15.9	-15.9	4.1	4.1	0.644	0.143	0.05	549.5	58.1	43.6	1260	0.75	9.46
30	-16.7	-16.7	4	4	0.665	0.125	0.05	410.4	55.8	32	1281	0.57	7.35
40	-17.7	-17.7	2.6	2.6	0.436	0.097	0.05	67.1	41.3	9.2	727	0.22	1.62
50	-19.1	-19.1	3.9	3.9	0.832	0.078	0.05	1103.2	53.4	113.6	971	2.13	20.66
60	-18.5	-18.5	2.2	2.2	0.389	0.082	0.05	61.3	36.4	8.7	704	0.24	1.68
80	-21.8	-21.8	2.7	2.7	0.835	0.038	0.05	125.4	38.9	18.6	675	0.48	3.22

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
EC	VV5											OACHI	OACHI
0	0.3	0.3	5.1	5.2	0.509	1.302	0.05	1584.1	64	146.9	1078	2.30	24.75
10	-4.2	-4.2	4.5	4.5	0.467	0.728	0.05	923.4	64	85.3	1082	1.33	14.43
20	-8.2	-8.2	3.5	3.5	0.384	0.415	0.05	336.7	56.9	31.1	1083	0.55	5.92
30	-10	-10	3.3	3.3	0.378	0.324	0.05	330.7	55.8	25.8	1283	0.46	5.93
40	-11.3	-11.3	2.3	2.3	0.267	0.256	0.05	616.9	35.2	91.4	675	2.60	17.53
60	-13.1	-13.1	2.1	2.1	0.259	0.196	0.05	84.3	35.2	12.2	692	0.35	2.39
80	-17.1	-17.1	2.6	2.6	0.414	0.108	0.05	144.5	41.3	21.4	675	0.52	3.50

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
EK	UHH5											OACHI	OACHI
0	-1.1	-1.1	4.8	4.8	0.48	1.08	0.05	2318.9	55.8	182.3	1272	3.27	41.56
10	-2.1	-2.1	5.3	5.3	0.54	0.983	0.05	6159.4	69.8	315.4	1953	4.52	88.24
20	-5.4	-5.4	3.1	3.1	0.32	0.58	0.05	1402.4	55.8	71.3	1967	1.28	25.13
30	-7.1	-7.1	2.7	2.7	0.285	0.457	0.05	277.3	49.8	14.1	1970	0.28	5.57
40	-8.8	-8.8	3.1	3.1	0.342	0.376	0.05	108.7	58.1	2.5	4319	0.04	1.87
50	-9.5	-9.5	3.1	3.1	0.348	0.342	0.05	118.9	55.8	3.3	3556	0.06	2.13
60	-10.6	-10.6	3	3	0.347	0.294	0.05	148.5	51	3.4	4316	0.07	2.91
70	-11.9	-11.9	2.6	2.6	0.311	0.24	0.05	198.1	43.8	6.6	2995	0.15	4.52
80	-14.8	-14.8	2.1	2.1	0.28	0.152	0.05	395.6	38.9	33.2	1190	0.85	10.17

IA	Mean	ResMean	StD	ResStD	Alpha	Beta	Gamma	TstStat	OACHI	NormTS	N	NTS/	TS/
EK	UHV0											OACHI	OACHI
40	-12.5	-12.5	3.5	3.5	0.318	0.285	0	98.8	56.9	4.2	1702	0.07	1.74
50	-13.3	-13.3	3.5	3.5	0.318	0.26	0	74.8	64	3.2	1715	0.05	1.17
60	-14	-14	3.2	3.2	0.29	0.236	0	121.2	51	5.3	1677	0.10	2.38
70	-15.4	-15.4	2.8	2.8	0.254	0.197	0	108.9	45	5.2	1549	0.12	2.42

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
EK UVV0 OACHi OACHi

0	-0.3	-0.3	4.3	4.4	0.392	1.21	0	2987.4	54.6	234.1	1276	4.29	54.71
10	-1.9	-1.9	5	5	0.454	1.043	0	10632	64	530.3	2005	8.29	166.13
20	-5.5	-5.5	3.3	3.3	0.299	0.63	0	1561.2	60.5	77.2	2021	1.28	25.80
30	-7.2	-7.2	3.3	3.3	0.299	0.518	0	180	58.1	8.9	2026	0.15	3.10
40	-9.2	-9.2	3.9	3.9	0.354	0.425	0	172	62.8	3.9	4373	0.06	2.74
50	-9.9	-9.9	3.8	3.8	0.345	0.39	0	261.6	58.1	7.2	3612	0.12	4.50
60	-10.9	-10.9	3.5	3.5	0.317	0.342	0	414.3	52.2	9.6	4306	0.18	7.94
70	-12.1	-12.1	3	3	0.272	0.29	0	501.2	46.2	16.7	3007	0.36	10.85
80	-13.9	-13.9	2.3	2.3	0.209	0.228	0	424.6	42.6	35.7	1188	0.84	9.97

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
EL HH5 OACHi OACHi

0	3.1	3.1	5.9	5.9	0.574	1.892	0.05	395.8	68.7	73.7	537	1.07	5.76
10	-7.1	-7.1	5.2	5.2	0.58	0.526	0.05	111.9	62.8	18.5	605	0.29	1.78
20	-13.4	-13.4	6.5	6.5	0.974	0.235	0.05	153.8	76.8	25.2	611	0.33	2.00
30	-16.2	-16.2	6.6	6.6	1.221	0.146	0.05	92.6	71	15.3	606	0.22	1.30
40	-19.9	-19.9	5.9	5.9	1.633	0.059	0.05	88.2	62.8	22.5	392	0.36	1.40
60	-22.1	-22.1	4.9	4.9	1.98	0.025	0.05	95.7	53.4	27.6	347	0.52	1.79
80	-23.8	-23.8	3.2	3.2	1.97	0.011	0.05	79.9	28.9	25.9	309	0.90	2.76

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
EL HV1 OACHi OACHi

0	-20.3	-20.3	5.6	5.6	0.619	0.119	0.01	324.6	60.5	93.3	348	1.54	5.37
10	-23.7	-23.7	4.7	4.7	0.555	0.073	0.01	189.6	59.3	39.9	475	0.67	3.20
20	-26	-26	5.9	5.9	0.801	0.056	0.01	137.7	72.2	27.5	500	0.38	1.91
30	-26.8	-26.8	6	6	0.852	0.05	0.01	82.7	68.7	16.5	500	0.24	1.20
40	-29.6	-29.6	4.9	4.9	0.787	0.031	0.01	49.4	59.3	13.7	361	0.23	0.83
60	-32.2	-32.2	4.2	4.2	0.82	0.019	0.01	82.3	51	26.6	309	0.52	1.61
80	-34.2	-34.2	3.6	3.6	0.881	0.012	0.01	125.4	46.2	40.8	307	0.88	2.71

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
EL VV3 OACHi OACHi

0	2.7	2.7	5.8	5.8	0.55	1.816	0.03	595.6	73.3	110.9	537	1.51	8.13
10	-7.2	-7.2	4.8	4.8	0.49	0.529	0.03	166	60.5	31.7	523	0.52	2.74
20	-14	-14	4.8	4.8	0.566	0.224	0.03	166.4	64	29.7	560	0.46	2.60
30	-16.6	-16.6	5	5	0.656	0.159	0.03	88.7	64	15.9	559	0.25	1.39
40	-19.6	-19.6	5.5	5.5	0.88	0.103	0.03	98.7	65.2	28.9	341	0.44	1.51
60	-21.6	-21.6	5.5	5.5	1.05	0.071	0.03	86.2	62.8	24.8	347	0.39	1.37
80	-23.5	-23.5	4	4	0.858	0.047	0.03	88.1	46.2	28.5	309	0.62	1.91

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
ES HH5 OACHi OACHi

0	1.3	1.3	5.9	5.9	0.583	1.528	0.05	347.9	80.2	65	535	0.81	4.34
10	-6.7	-6.7	4.4	4.4	0.477	0.529	0.05	165.6	64	31	534	0.48	2.59
20	-12	-12	3.7	3.7	0.46	0.252	0.05	101.3	55.8	18.9	535	0.34	1.82
30	-14.1	-14.1	3.4	3.4	0.46	0.183	0.05	64.9	52.2	12.1	535	0.23	1.24
40	-16.7	-16.7	2.7	2.7	0.419	0.116	0.05	47.2	38.9	14	337	0.36	1.21
60	-18.5	-18.5	2.6	2.6	0.471	0.084	0.05	38.5	37.7	11.4	337	0.30	1.02
80	-20.1	-20.1	2.5	2.5	0.551	0.06	0.05	23.3	36.4	6.9	337	0.19	0.64

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
ES HV3 OACHI OACHI

0	-17	-17	4.9	4.9	0.653	0.149	0.03	221.9	56.9	50.8	437	0.89	3.90
10	-19.9	-19.9	3.9	3.9	0.588	0.091	0.03	113.6	54.6	21.8	521	0.40	2.08
20	-21.5	-21.5	3.7	3.7	0.626	0.069	0.03	97.7	51	18.7	523	0.37	1.92
30	-22.1	-22.1	3.4	3.4	0.598	0.061	0.03	108.4	45	20.9	518	0.46	2.41
40	-23.8	-23.8	2.6	2.6	0.525	0.042	0.03	49.5	37.7	14.7	337	0.39	1.31
60	-25.4	-25.4	2.5	2.5	0.639	0.029	0.03	259.2	36.4	76.9	337	2.11	7.12
80	-28	-28	2.5	2.5	1.321	0.01	0.03	119.7	35.2	35.5	337	1.01	3.40

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
ES VV3 OACHI OACHI

0	1.3	1.3	5.8	5.8	0.554	1.541	0.03	465.5	79.1	87.3	533	1.10	5.88
10	-6.2	-6.2	4.4	4.4	0.441	0.585	0.03	241.3	65.2	45.1	535	0.69	3.70
15	-8.9	-8.9	3.7	3.7	0.38	0.404	0.03	79	49.8	41.2	192	0.83	1.59
20	-11.7	-11.7	3.4	3.4	0.365	0.28	0.03	124.8	52.2	23.4	534	0.45	2.39
30	-13.9	-13.9	3.1	3.1	0.348	0.207	0.03	169.9	45	31.9	533	0.71	3.78
40	-15.6	-15.6	3	3	0.354	0.163	0.03	178.4	40.1	52.9	337	1.32	4.45
50	-16.6	-16.6	3.1	3.1	0.377	0.143	0.03	28.1	23.7	117.1	24	4.94	1.19
60	-17	-17	3.2	3.2	0.4	0.136	0.03	28.3	47.4	8.4	337	0.18	0.60
80	-19.6	-19.6	2.9	2.9	0.408	0.091	0.03	58.4	42.6	17.3	337	0.41	1.37

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
AC HH0 OACHI OACHI

0	1.6	1.6	8.1	8.2	0.735	1.834	0	2747.8	80.2	400.6	687	5.00	34.26
5	-1.3	-1.3	4.9	4.9	0.442	1.11	0	429.3	58.1	73.5	584	1.27	7.39
10	-2.9	-2.9	4.7	4.7	0.426	0.915	0	861.7	62.8	54	1596	0.86	13.72
15	-4.4	-4.4	4.6	4.6	0.417	0.766	0	270.5	66.3	28.8	939	0.43	4.08
20	-7.3	-7.3	4.5	4.5	0.408	0.546	0	566.7	64	47	1205	0.73	8.85
25	-8.8	-8.8	4.9	4.9	0.445	0.469	0	128.5	51	91.8	140	1.80	2.52
30	-10.5	-10.5	4.5	4.5	0.408	0.377	0	540.5	65.2	67.1	805	1.03	8.29
35	-12	-12	3.6	3.6	0.327	0.303	0	46.7	42.6	33.4	140	0.78	1.10
40	-13.2	-13.2	4.4	4.4	0.399	0.275	0	64.6	58.1	16.5	392	0.28	1.11
45	-13.4	-13.4	2.9	2.9	0.263	0.249	0	41.8	36.4	28.1	149	0.77	1.15
50	-14.4	-14.4	3.7	3.7	0.336	0.231	0	100	48.6	30.5	328	0.63	2.06

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
AK UHH0 OACHI OACHI

0	-0.3	-0.3	5.7	5.7	0.517	1.3	0	14.7	25	61.3	24	2.45	0.59
5	-2	-2	4.5	4.5	0.408	1.004	0	16.2	23.7	77.1	21	3.25	0.68
10	-4.3	-4.3	4.7	4.7	0.427	0.779	0	14	31.4	51.7	27	1.65	0.45
15	-4.9	-4.9	5.5	5.5	0.499	0.758	0	11.4	22.4	52	22	2.32	0.51
20	-7.8	-7.8	5.1	5.1	0.463	0.532	0	27.3	36.4	80.4	34	2.21	0.75
30	-11.2	-11.2	4	4	0.363	0.339	0	12.1	28.9	38	32	1.31	0.42
40	-11	-11	4.1	4.1	0.372	0.349	0	15.1	23.7	75.7	20	3.19	0.64
50	-14.2	-14.2	4.3	4.3	0.39	0.244	0	30.9	33.9	77.1	40	2.27	0.91
60	-14.2	-14.2	4.9	4.9	0.445	0.252	0	15.6	26.3	70.8	22	2.69	0.59

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
AK UVV5 OACHI OACHI

0	-1	-1	5.1	5.1	0.513	1.112	0.05	26.9	32.7	89.8	30	2.75	0.82
10	-0.8	-0.8	4.5	4.5	0.447	1.102	0.05	59	53.4	34.9	169	0.65	1.10
20	-4.2	-4.2	4.5	4.5	0.467	0.728	0.05	77.7	55.8	44.4	175	0.80	1.39
30	-7.2	-7.2	3.5	3.5	0.376	0.472	0.05	42.5	46.2	24.4	174	0.53	0.92
40	-8.5	-8.5	2.5	2.5	0.271	0.377	0.05	38.5	35.2	24.4	158	0.69	1.09
50	-10.2	-10.2	3.3	3.3	0.38	0.316	0.05	48.6	43.8	26.7	182	0.61	1.11
60	-12.7	-12.7	4.3	4.3	0.563	0.236	0.05	17.9	23.7	81.2	22	3.43	0.76

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
AS HV0 OACHI OACHI

0	-14.5	-14.5	5.5	5.5	0.499	0.251	0	136.2	56.9	52.8	258	0.93	2.39
10	-20.3	-20.3	4.2	4.2	0.381	0.12	0	122.6	52.2	39.4	311	0.75	2.35
20	-23.1	-23.1	4.6	4.6	0.417	0.089	0	191.2	58.1	48.7	393	0.84	3.29
30	-24.7	-24.7	5.7	5.7	0.517	0.078	0	160	64	60.6	264	0.95	2.50
40	-24.9	-24.9	6.7	6.8	0.608	0.081	0	47.2	55.8	59	80	1.06	0.85

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
AX HH0 OACHI OACHI

0	5	5	7.4	7.5	0.671	2.615	0	30.4	28.9	121.7	25	4.21	1.05
10	-1.6	-1.6	5.1	5.1	0.463	1.085	0	32.9	40.1	76.5	43	1.91	0.82
20	-4.8	-4.8	4.2	4.2	0.381	0.716	0	22.9	38.9	41.6	55	1.07	0.59
30	-8.1	-8.1	4.3	4.3	0.39	0.492	0	38.1	45	40.6	94	0.90	0.85
40	-9.1	-9.1	5.5	5.5	0.499	0.467	0	40	45	69	58	1.53	0.89
50	-10.8	-10.8	5.2	5.2	0.472	0.378	0	83.7	51	89	94	1.75	1.64
60	-16.3	-16.3	6.4	6.5	0.581	0.214	0	113.2	60.5	89.9	126	1.49	1.87
70	-15.2	-15.2	6.3	6.4	0.571	0.241	0	41.5	48.6	72.9	57	1.50	0.85
80	-17.4	-17.4	5.6	5.6	0.508	0.181	0	10	32.7	37	27	1.13	0.31

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
BX HH5 OACHI OACHI

0	-8.5	-8.5	4.2	4.2	0.472	0.415	0.05	54.1	38.9	102	52	2.62	1.39
10	-8.3	-8.3	4.4	4.4	0.495	0.431	0.05	36.2	38.9	69.6	52	1.79	0.93
20	-9.8	-9.8	4	4	0.464	0.346	0.05	42.1	40.1	75.1	54	1.87	1.05
30	-10.4	-10.4	3.5	3.5	0.408	0.311	0.05	49.7	36.4	82.8	58	2.27	1.37
40	-11.6	-11.6	3.6	3.6	0.439	0.265	0.05	41.5	37.7	61.9	65	1.64	1.10
50	-12.1	-12.1	3.4	3.4	0.42	0.244	0.05	79.7	35.2	93.8	85	2.66	2.26
60	-12.9	-12.9	3.6	3.6	0.463	0.221	0.05	24.9	37.7	33.6	74	0.89	0.66
70	-14	-14	4.2	4.2	0.586	0.194	0.05	50.7	45	75.7	66	1.68	1.13
80	-13.5	-13.5	2.9	2.9	0.374	0.194	0.05	37.7	32.7	69.8	53	2.13	1.15

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
DC VV5 OACHI OACHI

0	-0.9	-0.9	4.7	4.8	0.471	1.102	0.05	1478.4	54.6	185.3	798	3.39	27.08
10	-5.1	-5.1	3.8	3.8	0.395	0.626	0.05	576.5	49.8	71.9	802	1.44	11.58
20	-8.4	-8.4	3.1	3.1	0.339	0.396	0.05	414.2	45	51.5	993	1.14	9.20
30	-9.7	-9.7	2.9	2.9	0.326	0.33	0.05	403.5	48.6	45.5	887	0.94	8.30
40	-11.5	-11.5	2.2	2.2	0.257	0.248	0.05	360.9	33.9	71.8	503	2.12	10.65
50	-12.9	-12.9	2.3	2.3	0.283	0.204	0.05	57.8	28.9	52.1	111	1.80	2.00
60	-13.2	-13.2	1.9	1.9	0.234	0.191	0.05	152.2	30.1	30	508	1.00	5.06
80	-17.6	-17.6	1.8	1.8	0.286	0.094	0.05	130.1	27.6	25.9	503	0.94	4.71

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
DL VV5 OACHI OACHI

0	0.8	0.8	4.2	4.3	0.414	1.317	0.05	483	59.3	122	396	2.06	8.15
10	-7.9	-7.9	5	5	0.565	0.469	0.05	113.8	59.3	29.8	382	0.50	1.92
20	-13.5	-13.5	4.6	4.6	0.636	0.213	0.05	67.2	54.6	16.9	398	0.31	1.23
30	-15.8	-15.8	4.4	4.4	0.696	0.148	0.05	53.2	55.8	13.4	397	0.24	0.95
40	-18.7	-18.7	4.5	4.5	0.95	0.086	0.05	80.1	52.2	33.9	236	0.65	1.53
60	-20.1	-20.1	4.4	4.4	1.125	0.061	0.05	88.7	51	36.8	241	0.72	1.74
80	-21.9	-21.9	3.2	3.2	1.059	0.036	0.05	68.1	36.4	30.5	223	0.84	1.87

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
HX HH3 OACHI OACHI

0	8.6	8.6	3.3	3.3	0.304	3.166	0.03	51.8	36.4	44.3	117	1.22	1.42
10	-4.5	-4.5	2.2	2.2	0.212	0.638	0.03	14.8	23.7	41.2	36	1.74	0.62
20	-7.6	-7.6	2	2	0.198	0.432	0.03	48.5	28.9	42.6	114	1.47	1.68
30	-10.2	-10.2	2.4	2.4	0.247	0.32	0.03	16.2	25	54	30	2.16	0.65
40	-9.4	-9.4	2.7	2.7	0.275	0.36	0.03	53.2	27.6	96.8	55	3.51	1.93
50	-12.1	-12.1	2.9	2.9	0.311	0.258	0.03	118.1	41.3	37.4	316	0.91	2.86
60	-15.9	-15.9	4.2	4.2	0.52	0.168	0.03	6.7	19.7	39.2	17	1.99	0.34
70	-16.9	-16.9	3	3	0.371	0.136	0.03	24.9	36.4	30.3	82	0.83	0.68

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
IC HH3 OACHI OACHI

0	8	8	3.9	3.9	0.36	3.047	0.03	40	43.8	28.4	141	0.65	0.91
10	-9.1	-9.1	4.4	4.4	0.459	0.41	0.03	53.4	48.6	55.1	97	1.13	1.10
20	-12.5	-12.5	4	4	0.443	0.261	0.03	50.9	51	34.4	148	0.67	1.00
30	-15	-15	4.1	4.1	0.489	0.189	0.03	28.5	47.4	27.9	102	0.59	0.60
50	-18.4	-18.4	4.5	4.5	0.635	0.119	0.03	94.8	53.4	44.3	214	0.83	1.78
70	-22.6	-22.6	4.4	4.4	0.864	0.058	0.03	68.9	49.8	49.9	138	1.00	1.38

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
IC HV0 OACHI OACHI

0	-6.1	-6.1	5.4	5.4	0.49	0.657	0	78.7	49.8	92.6	85	1.86	1.58
10	-20.7	-20.7	4.1	4.1	0.372	0.114	0	35.2	45	38.3	92	0.85	0.78
20	-21.8	-21.8	4.1	4.1	0.372	0.101	0	51.3	45	41.7	123	0.93	1.14
30	-24.2	-24.2	3.9	3.9	0.354	0.076	0	44.4	42.6	44.4	100	1.04	1.04
50	-26.3	-26.3	4.7	4.7	0.426	0.062	0	60.4	52.2	44.1	137	0.84	1.16
70	-28.1	-28.1	4.1	4.1	0.372	0.049	0	71	43.8	61.7	115	1.41	1.62

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
IC VV0 OACHI OACHI

0	7.6	7.6	4.5	4.5	0.408	3.032	0	53.4	46.2	41	130	0.89	1.16
10	-9.5	-9.5	4.2	4.2	0.381	0.417	0	65.2	45	67.3	97	1.50	1.45
20	-12.5	-12.5	4.2	4.2	0.381	0.295	0	42.4	47.4	34.2	124	0.72	0.89
30	-15.6	-15.6	3.7	3.7	0.336	0.201	0	41.7	42.6	40.1	104	0.94	0.98
50	-18.9	-18.9	4.6	4.6	0.417	0.144	0	40.2	53.4	23.5	171	0.44	0.75
70	-22.2	-22.2	4.6	4.6	0.417	0.099	0	57.2	46.2	55.5	103	1.20	1.24

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
IS HH0 OACHI OACHI

0	8.2	8.2	4	4	0.363	3.166	0	59.3	42.6	59.9	99	1.41	1.39
10	-7.3	-7.3	3.7	3.7	0.336	0.523	0	39.3	36.4	70.1	56	1.93	1.08
20	-12.3	-12.3	3.6	3.6	0.327	0.293	0	53.6	38.9	53.6	100	1.38	1.38
30	-15.8	-15.8	3.9	3.9	0.354	0.199	0	32.8	38.9	54.6	60	1.40	0.84
50	-19.6	-19.6	3.2	3.2	0.29	0.124	0	63.2	41.3	43	147	1.04	1.53
70	-26	-26	3.1	3.1	0.281	0.059	0	30.1	37.7	31	97	0.82	0.80

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IS HV0 OACHI OACHI

0	-10.3	-10.3	4.3	4.3	0.39	0.382	0	42.4	41.3	67.4	63	1.63	1.03
10	-21.1	-21.1	3.5	3.5	0.318	0.106	0	8.1	33.9	15.6	52	0.46	0.24
20	-23.2	-23.2	3.4	3.4	0.308	0.083	0	41.9	40.1	47.7	88	1.19	1.04
30	-25.9	-25.9	2.8	2.8	0.254	0.059	0	16.1	31.4	28.3	57	0.90	0.51
50	-28.9	-28.9	3.5	3.5	0.318	0.043	0	32	41.3	26.9	119	0.65	0.77
70	-33.5	-33.5	3.2	3.2	0.29	0.025	0	28.2	35.2	34.3	82	0.97	0.80

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IS VV0 OACHI OACHI

0	8.2	8.2	4	4	0.363	3.166	0	32	42.6	35.2	91	0.83	0.75
10	-7.1	-7.1	3.8	3.8	0.345	0.538	0	23.6	37.7	42.1	56	1.12	0.63
20	-11.6	-11.6	3.7	3.7	0.336	0.319	0	24.2	40.1	26.6	91	0.66	0.60
30	-15.1	-15.1	3.1	3.1	0.281	0.207	0	23.7	32.7	40.1	59	1.23	0.72
50	-19.4	-19.4	2.8	2.8	0.254	0.124	0	20.1	36.4	16.1	125	0.44	0.55
70	-25.3	-25.3	2.6	2.6	0.236	0.062	0	22.4	33.9	22.9	98	0.68	0.66

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
AC HV0 OACHI OACHI

0	-12.2	-12.2	6.6	6.7	0.599	0.346	0	835.9	67.5	134.2	688	1.99	12.38
5	-14.3	-14.3	4.6	4.6	0.417	0.245	0	203.7	56.9	38.4	584	0.67	3.58
10	-16.4	-16.4	4.9	4.9	0.444	0.195	0	752.3	59.3	79.4	1596	1.34	12.69
15	-17.3	-17.3	4.9	4.9	0.444	0.176	0	341.7	62.8	47.3	939	0.75	5.44
20	-19.3	-19.3	5.2	5.2	0.472	0.142	0	50087.3	67.5	5039	1205	74.65	742.03
25	-21.3	-21.3	4	4	0.363	0.106	0	40.4	46.2	28.2	140	0.61	0.87
30	-21.3	-21.3	5.6	5.6	0.508	0.115	0	185.9	81.4	23.6	805	0.29	2.28
35	-23.1	-23.1	4.2	4.2	0.381	0.087	0	59	46.2	41.5	140	0.90	1.28
40	-23	-23	5.7	5.7	0.517	0.095	0	103.1	73.3	26.7	392	0.36	1.41
45	-24.2	-24.2	3.9	3.9	0.354	0.076	0	52	46.2	34.4	149	0.74	1.13
50	-23.6	-23.6	4.9	4.9	0.444	0.085	0	778.1	55.8	265.6	328	4.76	13.94

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
AX HV0 OACHI OACHI

0	-9.3	-9.3	3.8	3.8	0.345	0.418	0	12.2	22.4	64.4	19	2.88	0.54
15	-14.1	-14.1	4.1	4.2	0.375	0.244	0	16.8	18.3	93.2	309	5.09	0.92
20	-16.2	-16.2	4.3	4.3	0.39	0.194	0	16.6	31.4	55.4	55	1.76	0.53
30	-18.6	-18.6	4.6	4.6	0.417	0.149	0	20.9	42.6	35.5	94	0.83	0.49
40	-19.5	-19.5	4.8	4.8	0.435	0.136	0	23.9	25	104.1	58	4.16	0.96
50	-20.3	-20.3	4.8	4.8	0.435	0.124	0	130.8	53.4	99.8	94	1.87	2.45
60	-23.9	-23.9	4.6	4.6	0.417	0.081	0	35.4	31.4	122.1	126	3.89	1.13
70	-25.1	-25.2	6.1	6.1	0.553	0.076	0	32.7	21	172.2	57	8.20	1.56

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
CX HV5 OACHI OACHI

20	-16.5	-16.5	3.2	3.2	0.501	0.124	0.05	20.8	41.3	13.6	153	0.33	0.50
30	-20.3	-20.3	3.5	3.5	0.868	0.058	0.05	41.8	42.6	20.8	201	0.49	0.98
40	-17.3	-17.3	3.3	3.3	0.555	0.109	0.05	82.6	47.4	13.6	607	0.29	1.74
50	-18.9	-18.9	3.7	3.7	0.759	0.081	0.05	254.4	51	20.5	1244	0.40	4.99
60	-18.7	-18.7	3.3	3.3	0.644	0.083	0.05	67.4	46.2	10	671	0.22	1.46
70	-19.1	-19.1	3.3	3.3	0.673	0.077	0.05	45.2	46.2	7	643	0.15	0.98

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
DK AVV0 OACHI OACHI

10	-6.9	-6.9	3.4	3.4	0.308	0.539	0	12.1	15.5	80.7	15	5.21	0.78
20	-6.1	-6.1	2.7	2.7	0.245	0.57	0	12.5	25	38.9	32	1.56	0.50
30	-6.8	-6.8	2.5	2.5	0.227	0.521	0	17.4	23.7	56.2	31	2.37	0.73
40	-8.1	-8.1	2.5	2.5	0.227	0.448	0	26.1	22.4	93.1	38	4.16	1.17
50	-8.6	-8.6	2.1	2.1	0.191	0.415	0	23.4	32.7	10	233	0.31	0.72
60	-10.3	-10.3	2.2	2.2	0.2	0.343	0	41.1	22.4	124.4	33	5.55	1.83
70	-11.9	-11.9	2.4	2.4	0.218	0.288	0	17.9	21	59.5	30	2.83	0.85

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
DX HV0 OACHI OACHI

20	-15.5	-15.5	3.1	3.1	0.281	0.197	0	84.1	42.6	49.2	171	1.15	1.97
30	-17.2	-17.2	4	4	0.363	0.17	0	47.5	47.4	29.7	160	0.63	1.00
40	-13.2	-13.2	2.2	2.2	0.2	0.245	0	82.1	38.9	5.6	1478	0.14	2.11
50	-16	-16	4.2	4.2	0.381	0.197	0	207.3	72.2	7.7	2690	0.11	2.87
60	-15.3	-15.3	2.4	2.4	0.218	0.195	0	68.4	43.8	4.5	1528	0.10	1.56
70	-17.3	-17.3	2.5	2.5	0.227	0.155	0	159.3	38.9	10.7	1492	0.28	4.10

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
EX HH5 OACHI OACHI

0	-1.8	-1.8	5.3	5.3	0.538	1.019	0.05	629.7	65.2	74.6	844	1.14	9.66
10	-2.1	-2.1	5.8	5.8	0.596	1.01	0.05	3548	74.5	249.9	1420	3.35	47.62
20	-6.1	-6.1	3.1	3.1	0.324	0.531	0.05	1886.9	53.4	126.8	1488	2.37	35.34
30	-7.8	-7.8	2.5	2.5	0.267	0.413	0.05	717.2	47.4	41.7	1718	0.88	15.13
40	-9.9	-9.9	2.7	2.7	0.304	0.317	0.05	226.6	51	6.6	3454	0.13	4.44
50	-11	-11	2.9	2.9	0.339	0.277	0.05	124.8	54.6	3.6	3459	0.07	2.29
60	-11.8	-11.8	2.7	2.7	0.322	0.245	0.05	1807.9	52.2	49.5	649	0.95	34.63
70	-13.6	-13.6	2.7	2.7	0.347	0.189	0.05	249	48.6	9.4	2658	0.19	5.12
80	-15.6	-15.6	2.3	2.3	0.324	0.136	0.05	275.7	38.9	32.5	847	0.84	7.09

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
EX VV5 OACHI OACHI

0	-1.6	-1.6	5.3	5.3	0.536	1.044	0.05	938.8	61.7	110.8	847	1.80	15.22
10	-2.3	-2.3	5.8	5.8	0.598	0.986	0.05	2907.5	66.3	205.2	1417	3.10	43.85
20	-6.5	-6.5	3.1	3.1	0.326	0.505	0.05	1549.4	49.8	92.6	1673	1.86	31.11
30	-8.6	-8.6	2.9	2.9	0.317	0.381	0.05	223	47.4	13.1	1708	0.28	4.70
40	-10.6	-10.6	3.4	3.4	0.398	0.301	0.05	177.9	58.1	5.2	3449	0.09	3.06
50	-10.8	-10.8	3.6	3.6	0.427	0.296	0.05	143.8	58.1	2.8	5083	0.05	2.48
60	-12.3	-12.3	2.9	2.9	0.355	0.231	0.05	84	51	2.4	3544	0.05	1.65
70	-13.7	-13.7	2.9	2.9	0.377	0.189	0.05	268.8	51	10.1	2658	0.20	5.27
80	-16.1	-16.1	2.6	2.6	0.383	0.128	0.05	198.1	42.6	23.7	837	0.56	4.65

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
HL HV0 OACHI OACHI

0	-12.6	-12.6	4.9	4.9	0.445	0.303	0	28.9	38.9	61.5	47	1.58	0.74
10	-23.3	-23.3	4.7	4.7	0.426	0.087	0	36.7	42.6	65.5	56	1.54	0.86
20	-28.6	-28.7	5.8	5.8	0.526	0.05	0	45.6	52.2	59.2	77	1.13	0.87
30	-34.3	-34.3	4.2	4.2	0.381	0.024	0	48.9	36.4	99.8	49	2.74	1.34
50	-33.7	-33.8	6.6	6.7	0.599	0.029	0	40.2	48.6	78.8	51	1.62	0.83
70	-39.1	-39.1	4.4	4.4	0.399	0.014	0	29.4	36.4	75.4	39	2.07	0.81

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
HK UHH0 OACHI OACHI

0	8.9	8.9	3.4	3.4	0.308	3.325	0	50.3	41.3	22.3	225	0.54	1.22
10	-2.8	-2.8	2.6	2.6	0.236	0.83	0	42.2	32.7	49.1	86	1.50	1.29
20	-5.2	-5.2	2.8	2.8	0.254	0.636	0	39.2	40.1	17.8	220	0.44	0.98
30	-6	-6	3.6	3.6	0.327	0.605	0	23.5	40.1	29.4	80	0.73	0.59
40	-8.7	-8.7	2.6	2.6	0.236	0.421	0	31.3	31.4	34.8	90	1.11	1.00
50	-9.1	-9.1	3	3	0.272	0.41	0	296.7	45	56.7	523	1.26	6.59
70	-12.6	-12.6	3.4	3.4	0.308	0.28	0	57.2	45	31.1	184	0.69	1.27

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
HW VV0 OACHI OACHI

0	2.2	2.2	2.7	2.7	0.245	1.483	0	13.4	19.7	74.3	18	3.77	0.68
10	-0.5	-0.5	4.2	4.3	0.384	1.177	0	17.6	26.3	80	22	3.04	0.67
20	-0.5	-0.5	3	3	0.269	1.102	0	20.7	26.3	76.6	27	2.91	0.79
30	-1.7	-1.7	3.9	3.9	0.354	1.008	0	11.3	23.7	59.3	19	2.50	0.48
40	-2.8	-2.9	3.7	3.7	0.336	0.874	0	206.6	33.9	382.5	54	11.28	6.09
55	-3.3	-3.3	2.2	2.2	0.2	0.767	0	11.9	19.7	49.5	24	2.51	0.60
70	-6.5	-6.5	3.3	3.3	0.299	0.562	0	15.3	19.7	85.1	18	4.32	0.78

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IL HH0 OACHI OACHI

0	6.4	6.4	5.1	5.1	0.463	2.726	0	53.9	52.2	51.4	105	0.98	1.03
10	-8.1	-8.1	5	5	0.454	0.511	0	35.2	42.6	63.9	55	1.50	0.83
20	-14.8	-14.8	5.4	5.4	0.49	0.241	0	85.1	49.8	107.7	79	2.16	1.71
30	-20.1	-20.1	4.7	4.7	0.426	0.126	0	33.6	41.3	58	58	1.40	0.81
50	-22.9	-22.9	4.4	4.4	0.399	0.09	0	73.2	49.8	61	120	1.22	1.47
70	-28.7	-28.7	3.1	3.1	0.281	0.043	0	25	35.2	32.9	76	0.93	0.71

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IL HV0 OACHI OACHI

0	-12	-12	5.2	5.2	0.472	0.329	0	17.5	40.1	42.6	41	1.06	0.44
10	-22.8	-22.8	5.1	5.1	0.463	0.095	0	24.8	41.3	49.7	50	1.20	0.60
20	-25.7	-25.7	6.1	6.1	0.553	0.071	0	51.1	53.4	70	73	1.31	0.96
30	-31.6	-31.6	3.8	3.8	0.345	0.032	0	28.8	35.2	61.4	47	1.74	0.82
50	-30.9	-30.9	4.9	4.9	0.445	0.037	0	40.8	46.2	56.7	72	1.23	0.88
70	-36.1	-36.1	3.7	3.7	0.336	0.019	0	15	32.7	36.6	41	1.12	0.46

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IL VV2 OACHI OACHI

0	6.7	6.7	4.4	4.4	0.405	2.7	0.02	33.2	46.2	35.7	93	0.77	0.72
10	-7.2	-7.2	5.6	5.6	0.555	0.564	0.02	50.1	46.2	89.4	56	1.94	1.08
20	-14.2	-14.2	5.4	5.4	0.593	0.237	0.02	73.8	52.2	94.6	78	1.81	1.41
30	-19.9	-19.9	4	4	0.502	0.103	0.02	25.8	41.3	44.5	58	1.08	0.62
50	-22.4	-22.4	4	4	0.567	0.072	0.02	60.9	46.2	58.6	104	1.27	1.32
70	-28.3	-28.3	3.4	3.4	0.841	0.023	0.02	23.9	37.7	29.5	81	0.78	0.63

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IK AVV0 OACHI OACHI

0	2.1	2.1	6.4	6.5	0.581	1.778	0	35.9	49.8	69	52	1.39	0.72
20	-2.8	-2.8	6.1	6.2	0.554	0.996	0	33.3	45	72.4	46	1.61	0.74
40	-4.5	-4.5	5.2	5.2	0.472	0.781	0	35.7	25	142.8	25	5.71	1.43
55	-7.1	-7.1	5	5	0.454	0.573	0	18.1	22.4	95.1	19	4.25	0.81

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
AC VV5 OACHI OACHI

0	2.1	2.1	8.4	8.4	0.856	1.921	0.05	952.6	89.4	139.7	682	1.56	10.66
10	-2.6	-2.6	4.8	4.8	0.488	0.9	0.05	419.6	66.3	39.9	1052	0.60	6.33
20	-7	-7	4.2	4.2	0.456	0.504	0.05	224.3	66.3	21.4	1047	0.32	3.38
30	-10.3	-10.3	4.5	4.5	0.539	0.333	0.05	182	65.2	27.7	657	0.42	2.79
40	-12.9	-12.9	4.2	4.2	0.553	0.228	0.05	59.6	55.8	24.1	247	0.43	1.07
50	-14.2	-14.2	3.6	3.6	0.495	0.182	0.05	35.2	43.8	29.6	119	0.68	0.80

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
AK UHV0 OACHI OACHI

10	-18.6	-18.6	5.1	5.1	0.463	0.153	0	16.1	19.7	100.9	11	5.12	0.82
20	-20.1	-20.1	7.3	7.4	0.662	0.145	0	23.6	25	112.2	21	4.49	0.94
30	-24.2	-24.2	4.7	4.7	0.426	0.079	0	10.2	21	56.7	18	2.70	0.49
50	-22.5	-22.5	6.3	6.4	0.571	0.104	0	36.2	31.4	125	29	3.98	1.15

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
DK AHH0 OACHI OACHI

20	-5.8	-5.8	2.9	2.9	0.263	0.597	0	14.8	26.3	51	29	1.94	0.56
30	-6.4	-6.4	3	3	0.272	0.56	0	20.2	26.3	69.6	29	2.65	0.77
40	-7.7	-7.7	2.9	2.9	0.263	0.479	0	12.2	25	48.7	25	1.95	0.49
50	-8.8	-8.8	2	2	0.181	0.403	0	44.8	31.4	19.5	230	0.62	1.43
60	-9.9	-9.9	2.7	2.7	0.245	0.368	0	21.4	23.7	73.8	29	3.11	0.90
70	-11.6	-11.6	2.9	2.9	0.263	0.306	0	10.2	25	35.2	29	1.41	0.41

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
HC HV0 OACHI OACHI

0	-7.4	-7.4	6.7	6.8	0.608	0.605	0	48.7	61.7	48.7	100	0.79	0.79
10	-20.4	-20.4	4.1	4.1	0.372	0.118	0	51.8	46.2	45.1	115	0.98	1.12
20	-21.5	-21.5	4.1	4.1	0.372	0.104	0	60.9	46.2	42.9	142	0.93	1.32
30	-23.5	-23.5	3.4	3.4	0.308	0.08	0	38.4	40.1	33.1	116	0.83	0.96
50	-25.7	-25.7	4.6	4.6	0.417	0.066	0	46.5	51	31	150	0.61	0.91
70	-28.3	-28.3	4.2	4.2	0.381	0.048	0	108.4	43.8	75.8	143	1.73	2.47

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IK UHH0 OACHI OACHI

0	8.1	8.1	4.1	4.1	0.372	3.146	0	98	51	46.2	212	0.91	1.92
10	-3.8	-3.8	3.9	3.9	0.354	0.791	0	45.8	38.9	50.3	91	1.29	1.18
20	-8	-8	4.2	4.2	0.381	0.496	0	101.8	47.4	45.3	225	0.96	2.15
30	-8.2	-8.2	5.4	5.4	0.49	0.516	0	61.7	47.4	68.6	90	1.45	1.30
50	-14.3	-14.3	5.3	5.3	0.481	0.254	0	479.2	55.8	121.3	395	2.17	8.59
70	-15.4	-15.4	4.8	4.8	0.435	0.218	0	57.6	55.8	29.2	197	0.52	1.03

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
AK AHH0 OACHI OACHI

10	-6	-6	3.3	3.3	0.299	0.595	0	6.7	9.5	95.8	7	10.08	0.71
20	-6.3	-6.3	3	3	0.272	0.566	0	7.5	12.6	74.8	10	5.94	0.60
30	-6.8	-6.8	2.7	2.7	0.245	0.526	0	4.7	12.6	47.4	10	3.76	0.37
40	-8.3	-8.3	2.9	2.9	0.263	0.447	0	6.6	12.6	65.9	10	5.23	0.52
50	-10	-10	3.1	3.1	0.281	0.372	0	3.3	12.6	32.9	10	2.61	0.26
60	-11.7	-11.7	3.6	3.6	0.327	0.314	0	2.2	14.1	22	10	1.56	0.16
70	-14.7	-14.7	3.5	3.5	0.318	0.221	0	6.9	14.1	76.2	9	5.40	0.49
80	-15.5	-15.5	2.8	2.8	0.254	0.194	0	0.4	9.5	6.7	6	0.71	0.04

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
AK AVV0 OACHI OACHI

10	-9.6	-9.6	5.6	5.6	0.508	0.443	0	7.7	16.9	64.3	12	3.80	0.46
20	-9.9	-9.9	5	5	0.453	0.415	0	8.8	19.7	59	15	2.99	0.45
30	-10	-10	5.1	5.1	0.463	0.413	0	16.4	19.7	109.1	15	5.54	0.83
40	-11.7	-11.7	4.9	4.9	0.445	0.336	0	14.6	19.7	97.2	15	4.93	0.74
50	-12.9	-12.9	4.9	4.9	0.444	0.292	0	10.1	18.3	67.2	15	3.67	0.55
60	-14.4	-14.4	4.9	4.9	0.445	0.246	0	3.5	16.9	23.4	15	1.38	0.21
70	-16.9	-16.9	4.9	4.9	0.444	0.184	0	6.8	18.3	48.9	14	2.67	0.37
80	-19.7	-19.7	5.5	5.5	0.499	0.138	0	3.9	11.1	48.5	8	4.37	0.35

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
BC HH0 OACHI OACHI

0	-10.3	-10.3	1.6	1.6	0.145	0.332	0	0.2	6	5.5	4	0.92	0.03
20	-11	-11	2.6	2.6	0.236	0.323	0	2.5	12.6	27.7	7	2.20	0.20
40	-11	-11	2.5	2.5	0.227	0.321	0	4.9	9.5	61.8	6	6.51	0.52
55	-8.9	-8.9	0.7	0.7	0.063	0.372	0	179.9	11.1	153.7	117	13.85	16.21

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
BC HV0 OACHI OACHI

0	-16.3	-16.3	1.1	1.1	0.1	0.162	0	0.5	6	10.6	5	1.77	0.08
20	-17.1	-17.1	2.9	2.9	0.263	0.162	0	4.8	14.1	43.3	7	3.07	0.34
30	-16.5	-16.5	2	2	0.181	0.166	0	5.5	14.1	50.2	7	3.56	0.39
40	-17.4	-17.4	2.4	2.4	0.218	0.153	0	8.6	14.1	78.2	7	5.55	0.61
60	-22	-22	1.5	1.5	0.136	0.086	0	0.2	6	5.6	4	0.93	0.03
80	-24.8	-24.8	1.2	1.2	0.109	0.061	0	0.4	6	11	4	1.83	0.07

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
BC VV0 OACHI OACHI

0	-10.2	-10.2	1.7	1.7	0.154	0.338	0	0.9	6	18.7	5	3.12	0.15
20	-10.8	-10.8	2.8	2.8	0.254	0.334	0	5.9	14.1	53.6	7	3.80	0.42
40	-10.6	-10.6	2.3	2.3	0.209	0.333	0	6.2	12.6	61.8	7	4.90	0.49
80	-19	-19	1.5	1.5	0.136	0.121	0	1.2	6	29.4	4	4.90	0.20

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
BK AVV0 OACHI OACHI

10	-10.6	-10.6	2.6	2.6	0.236	0.338	0	0.1	6	2.3	4	0.38	0.02
20	-11.2	-11.2	2.9	2.9	0.263	0.32	0	0.1	7.8	1.5	5	0.19	0.01
30	-12.1	-12.1	3.2	3.2	0.29	0.293	0	4.6	7.8	91.7	5	11.76	0.59
40	-12.7	-12.7	1.5	1.5	0.136	0.251	0	0.4	7.8	7.6	5	0.97	0.05
50	-15.2	-15.2	4.4	4.4	0.399	0.219	0	1.4	7.8	27.8	5	3.56	0.18
60	-15.5	-15.5	2.5	2.5	0.227	0.191	0	0.1	6	3.4	4	0.57	0.02

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
BL HV0 OACHi OACHi

20	-16.7	-16.7	4.3	4.3	0.39	0.183	0	0	6	0.8	4	0.13	0.00
30	-18.7	-18.7	4.1	4.1	0.372	0.144	0	1.7	9.5	28.4	6	2.99	0.18
40	-20.7	-20.7	3.1	3.1	0.281	0.108	0	3.1	14.1	25.6	12	1.82	0.22
50	-19.2	-19.2	1.3	1.3	0.118	0.117	0	12.5	16.9	26.6	47	1.57	0.74
60	-18.8	-18.8	4.5	4.5	0.408	0.145	0	3.7	9.5	62.2	6	6.55	0.39

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
BL VV0 OACHi OACHi

30	-13.1	-13.1	4.3	4.3	0.39	0.277	0	1.4	6	34.2	4	5.70	0.23
40	-14.5	-14.5	3.1	3.1	0.281	0.221	0	1	9.5	13.8	7	1.45	0.11
50	-10.9	-10.9	1.8	1.8	0.163	0.313	0	9.9	18.3	41.4	24	2.26	0.54
60	-16.9	-16.9	7.5	7.6	0.68	0.211	0	2	6	50.9	4	8.48	0.33

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
CK AHH5 OACHi OACHi

10	-7	-7	2.5	2.5	0.263	0.458	0.05	7.9	19.7	41.5	19	2.11	0.40
20	-6.4	-6.4	3	3	0.315	0.509	0.05	17.8	28.9	46.9	38	1.62	0.62
30	-7.6	-7.6	2.8	2.8	0.299	0.431	0.05	21.8	28.9	57.5	38	1.99	0.75
40	-8.8	-8.8	2.9	2.9	0.319	0.371	0.05	8	28.9	24.9	32	0.86	0.28
50	-11	-11	3.4	3.4	0.403	0.285	0.05	25.5	36.4	49.1	52	1.35	0.70
60	-10.5	-10.5	3.1	3.1	0.359	0.299	0.05	21.2	28.9	55.8	38	1.93	0.73
70	-11.7	-11.7	3.3	3.3	0.4	0.257	0.05	15.5	32.7	40.8	38	1.25	0.47
80	-14.8	-14.8	3.8	3.8	0.546	0.168	0.05	3.5	16.9	23.4	15	1.38	0.21

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
CK AVV5 OACHi OACHi

10	-7.7	-7.7	1.9	1.9	0.2	0.405	0.05	10.2	18.3	53.8	19	2.94	0.56
20	-7.1	-7.1	2.6	2.6	0.274	0.455	0.05	26.9	25	70.7	38	2.83	1.08
30	-7.9	-7.9	2.7	2.7	0.29	0.413	0.05	25.7	26.3	61.2	42	2.33	0.98
40	-9.3	-9.3	2.6	2.6	0.287	0.342	0.05	21	26.3	65.5	32	2.49	0.80
50	-11.4	-11.4	3.5	3.5	0.422	0.271	0.05	18.3	36.4	35.9	51	0.99	0.50
60	-10.8	-10.8	2.8	2.8	0.324	0.283	0.05	5.7	28.9	15.1	38	0.52	0.20
70	-12.4	-12.4	2.7	2.7	0.33	0.225	0.05	16.2	27.6	46.1	35	1.67	0.59
80	-15.4	-15.4	3	3	0.43	0.147	0.05	3.4	15.5	28.6	12	1.85	0.22

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
CK UHV5 OACHi OACHi

40	-16.2	-16.2	3.2	3.2	0.49	0.13	0.05	119.4	47.4	18	662	0.38	2.52
50	-16.9	-16.9	3.3	3.3	0.538	0.116	0.05	102.3	47.4	15.8	648	0.33	2.16
60	-17	-17	3.4	3.4	0.561	0.115	0.05	72.1	47.4	12	601	0.25	1.52
70	-17.1	-17.1	3.4	3.4	0.566	0.113	0.05	44.7	43.8	8.2	544	0.19	1.02

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
CW VV0 OACHi OACHi

10	-0.9	-0.9	1.1	1.1	0.1	0.955	0	0.9	6	22	4	3.67	0.15
20	-1.7	-1.7	1.7	1.7	0.154	0.898	0	0.6	6	15.7	4	2.62	0.10
30	-3.1	-3.1	2.2	2.2	0.2	0.785	0	0.7	6	16.9	4	2.82	0.12
40	-3	-3	1.2	1.2	0.109	0.754	0	0.4	6	8.8	4	1.47	0.07
50	-3	-3	1.9	1.9	0.172	0.781	0	1.8	6	45.2	4	7.53	0.30

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
EK AHH0 OACHI OACHI

10	-6.7	-6.7	3	3	0.272	0.541	0	15.4	26.3	48	32	1.83	0.59
20	-6.1	-6.1	3	3	0.272	0.579	0	17.6	31.4	26.3	67	0.84	0.56
30	-7	-7	2.9	2.9	0.263	0.52	0	27.2	31.4	40.5	67	1.29	0.87
40	-8.3	-8.3	2.9	2.9	0.263	0.447	0	18.8	31.4	33	57	1.05	0.60
50	-9.2	-9.2	2.5	2.5	0.227	0.395	0	37.5	40.1	13.3	282	0.33	0.94
60	-10.2	-10.2	3	3	0.272	0.361	0	37.1	33.9	55.4	67	1.63	1.09
70	-11.6	-11.6	3.1	3.1	0.281	0.309	0	32.5	35.2	48.4	67	1.38	0.92
80	-15.2	-15.2	3.9	3.9	0.354	0.213	0	8.5	27.6	34.1	25	1.24	0.31

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
EK AVV0 OACHI OACHI

0	-5	-5	5.5	5.5	0.499	0.749	0	2	6	49.9	4	8.32	0.33
10	-7.4	-7.4	2.7	2.7	0.245	0.491	0	32.1	25	94.5	34	3.78	1.28
20	-6.7	-6.7	2.7	2.7	0.245	0.532	0	57.6	27.6	82.2	70	2.98	2.09
30	-7.4	-7.4	2.6	2.6	0.236	0.489	0	44.2	28.9	60.6	73	2.10	1.53
40	-8.7	-8.7	2.6	2.6	0.236	0.421	0	39.7	30.1	66.2	60	2.20	1.32
50	-9.1	-9.1	2.7	2.7	0.245	0.404	0	38.7	41.3	13.6	284	0.33	0.94
60	-10.6	-10.6	2.5	2.5	0.227	0.336	0	34.7	31.4	48.8	71	1.55	1.11
70	-12.1	-12.1	2.6	2.6	0.236	0.284	0	15.5	28.9	23.9	65	0.83	0.54
80	-15.4	-15.4	2.3	2.3	0.209	0.191	0	6.6	21	28.8	23	1.37	0.31

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
FK AHH0 OACHI OACHI

0	17.3	17.3	10	10.1	0.907	12.34	0	10.1	11.1	126.1	8	11.36	0.91
10	-4.6	-4.6	2.7	2.7	0.245	0.678	0	19	25	73.2	26	2.93	0.76
20	-7.7	-7.7	3.1	3.1	0.281	0.484	0	8.1	26.3	31.2	26	1.19	0.31
30	-10.2	-10.2	3.5	3.5	0.318	0.371	0	12.5	26.3	47.9	26	1.82	0.48
40	-12.6	-12.6	4.2	4.2	0.381	0.292	0	13.6	28.9	52.3	26	1.81	0.47
50	-15.5	-15.5	4.8	4.8	0.436	0.216	0	40.1	30.1	154.1	26	5.12	1.33
60	-18.2	-18.2	4.7	4.7	0.426	0.157	0	17.7	28.9	70.6	25	2.44	0.61
70	-22.7	-22.7	5.1	5.1	0.463	0.096	0	19.2	28.9	80	24	2.77	0.66
80	-28.6	-28.6	5.6	5.6	0.508	0.05	0	6.6	18.3	50.9	13	2.78	0.36

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
FK AHV0 OACHI OACHI

10	-15	-15	4.9	4.9	0.445	0.23	0	5.7	14.1	56.7	10	4.02	0.40
20	-16.2	-16.2	4.8	4.8	0.435	0.199	0	2.7	14.1	26.9	10	1.91	0.19
30	-17.3	-17.3	4.8	4.8	0.435	0.175	0	5.2	12.6	52.5	10	4.17	0.41
40	-18.6	-18.6	5.4	5.4	0.49	0.156	0	3.7	14.1	36.7	10	2.60	0.26
50	-20.1	-20.1	5.4	5.4	0.49	0.131	0	7.6	15.5	75.5	10	4.87	0.49
60	-20.2	-20.2	2.5	2.5	0.227	0.111	0	2.3	11.1	28.6	8	2.58	0.21
70	-24.2	-24.2	2.8	2.8	0.254	0.071	0	4.4	11.1	55.6	8	5.01	0.40

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
FK AVV0 OACHI OACHI

0	16.5	16.5	10	10.1	0.907	11.254	0	11.1	14.1	111.3	10	7.89	0.79
10	-4.3	-4.3	2.8	2.8	0.254	0.705	0	14.1	25	54.3	26	2.17	0.56
20	-7.2	-7.2	3.6	3.6	0.327	0.527	0	11.8	27.6	45.2	26	1.64	0.43
30	-8.6	-8.6	3.1	3.1	0.281	0.437	0	12.7	26.3	48.7	26	1.85	0.48
40	-10	-10	3.5	3.5	0.318	0.38	0	23.4	27.6	89.9	26	3.26	0.85
50	-11.7	-11.7	3.6	3.6	0.327	0.314	0	31.5	27.6	121.3	26	4.39	1.14
60	-13.4	-13.4	3	3	0.272	0.25	0	26.8	25	111.5	24	4.46	1.07
70	-17.6	-17.6	4.5	4.5	0.408	0.167	0	16.4	27.6	68.1	24	2.47	0.59
80	-22	-22	3.2	3.2	0.29	0.094	0	7.3	15.5	55.9	13	3.61	0.47

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
FK UHH0 OACHI OACHI

0	18.5	18.5	9.8	9.9	0.889	14.066	0	8	12.6	100.2	8	7.95	0.63
10	-6.8	-6.8	5.1	5.1	0.462	0.596	0	13	19.7	72.2	18	3.66	0.66
20	-8.9	-8.9	5.2	5.2	0.472	0.471	0	9.2	21	51	18	2.43	0.44
30	-10	-10	5.7	5.7	0.517	0.426	0	18.4	22.4	102	18	4.55	0.82
40	-10.5	-10.5	5.5	5.5	0.499	0.398	0	8.2	21	45.6	18	2.17	0.39
50	-10.7	-10.7	6.6	6.7	0.599	0.412	0	8.5	23.7	47.4	18	2.00	0.36
60	-8.6	-8.6	5.6	5.6	0.508	0.497	0	4	21	24.7	16	1.18	0.19
70	-9	-9	9.4	9.5	0.853	0.579	0	8.6	19.7	53.9	16	2.74	0.44
80	-6	-6	13.9	14	1.261	1.034	0	7.8	14.1	64.8	12	4.60	0.55

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
FK UHV0 OACHI OACHI

5	-9.5	-9.5	2.7	2.7	0.245	0.386	0	1.9	6	48.2	4	8.03	0.32
10	-13.5	-13.5	5.6	5.6	0.508	0.283	0	5.3	12.6	66.3	8	5.26	0.42
15	-15.3	-15.3	5.9	5.9	0.535	0.234	0	4.2	11.1	52.1	8	4.69	0.38
20	-16.5	-16.5	6.1	6.1	0.553	0.206	0	5.6	11.1	79.4	7	7.15	0.50
30	-18	-18	7.6	7.7	0.689	0.187	0	3.7	11.1	46.4	8	4.18	0.33
40	-19.8	-19.8	7.1	7.2	0.644	0.148	0	8.1	11.1	101.6	8	9.15	0.73
50	-22	-22	7.5	7.6	0.68	0.117	0	4	12.6	50.3	8	3.99	0.32
60	-21.1	-21.1	2.7	2.7	0.245	0.101	0	2.7	7.8	45	6	5.77	0.35
70	-25.7	-25.7	3.2	3.2	0.29	0.061	0	2.4	9.5	39.6	6	4.17	0.25

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
FK UVV0 OACHI OACHI

0	18.6	18.6	9.6	9.7	0.871	14.066	0	17.4	12.6	217.2	8	17.24	1.38
10	-7.2	-7.2	5.5	5.5	0.499	0.581	0	16.1	21	89.6	18	4.27	0.77
20	-9.2	-9.2	5.3	5.3	0.481	0.457	0	8.1	21	45.1	18	2.15	0.39
30	-10	-10	5.7	5.7	0.517	0.426	0	3.9	22.4	21.4	18	0.96	0.17
40	-10.6	-10.6	5.5	5.5	0.499	0.393	0	6	22.4	33.3	18	1.49	0.27
50	-10.5	-10.5	5.8	5.8	0.526	0.404	0	16.5	22.4	91.6	18	4.09	0.74
60	-8.5	-8.5	3.9	3.9	0.354	0.461	0	6.8	18.3	42.3	16	2.31	0.37
70	-8.1	-8.1	6.5	6.6	0.589	0.552	0	12.1	21	75.4	16	3.59	0.58
80	-5.3	-5.3	10.3	10.4	0.934	0.929	0	21.4	15.5	178.7	12	11.53	1.38

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
FX HH0 OACHi OACHi

0	18.6	18.6	8.2	8.3	0.744	13.051	0	4.2	11.1	60.5	7	5.45	0.38
10	-12	-12	5	5	0.454	0.326	0	22.8	22.4	113.8	20	5.08	1.02
20	-16.1	-16.1	4.2	4.2	0.381	0.195	0	6.6	23.7	32.9	20	1.39	0.28
30	-18.7	-18.7	4.9	4.9	0.445	0.15	0	9.5	21	47.3	20	2.25	0.45
40	-21.1	-21.1	4.5	4.5	0.408	0.111	0	12.8	22.4	64.1	20	2.86	0.57
50	-23.8	-23.9	4.7	4.7	0.426	0.082	0	7.8	21	39.1	20	1.86	0.37
60	-26.4	-26.4	4.1	4.1	0.372	0.059	0	12.4	21	69.1	18	3.29	0.59
70	-31.4	-31.4	3.8	3.8	0.345	0.033	0	15.5	22.4	86	18	3.84	0.69
80	-39.8	-39.8	4.5	4.5	0.408	0.013	0	8.1	18.3	58	14	3.17	0.44

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
FX HV0 OACHi OACHi

10	-19.8	-19.8	4.1	4.1	0.372	0.127	0	1.7	9.5	28.7	6	3.02	0.18
15	-22.1	-22.1	4.1	4.1	0.372	0.097	0	4.2	11.1	52.1	8	4.69	0.38
20	-22.5	-22.5	4.1	4.1	0.372	0.093	0	2.1	11.1	26.2	8	2.36	0.19
30	-24.1	-24.1	4.9	4.9	0.445	0.081	0	2.1	12.6	26.6	8	2.11	0.17
40	-26.6	-26.6	4.7	4.7	0.426	0.06	0	3.8	12.6	47.7	8	3.79	0.30
50	-29.6	-29.6	5.5	5.5	0.499	0.044	0	3.1	11.1	39.3	8	3.54	0.28
60	-31.7	-31.7	4.6	4.6	0.417	0.033	0	5.1	11.1	72.7	7	6.55	0.46
70	-34.6	-34.6	2.4	2.4	0.218	0.021	0	1	9.5	16.5	6	1.74	0.11

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
FX VV0 OACHi OACHi

0	19.1	19.1	7.9	8	0.717	13.611	0	8.9	11.1	126.6	7	11.41	0.80
10	-12.9	-12.9	4.2	4.2	0.381	0.282	0	18.1	23.7	90.4	20	3.81	0.76
15	-18	-18	3.6	3.6	0.326	0.152	0	13.1	9.5	164.2	8	17.28	1.38
20	-15.5	-15.5	4	4	0.363	0.207	0	14.9	25	74.4	20	2.98	0.60
30	-17	-17	4.5	4.5	0.408	0.179	0	4.8	23.7	24.2	20	1.02	0.20
40	-18.5	-18.5	4.2	4.2	0.381	0.148	0	11.9	23.7	59.6	20	2.51	0.50
50	-20.3	-20.3	4.3	4.3	0.39	0.121	0	5.5	22.4	28.7	19	1.28	0.25
60	-22.1	-22.1	3.7	3.7	0.336	0.095	0	9.1	22.4	48.1	19	2.15	0.41
70	-25.1	-25.1	3.5	3.5	0.318	0.067	0	12.4	21	68.9	18	3.28	0.59
80	-31.8	-31.8	4.8	4.8	0.435	0.033	0	10.6	18.3	75.6	14	4.13	0.58

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
HC HH0 OACHi OACHi

0	7.6	7.6	4.4	4.4	0.399	3.017	0	72.4	55.8	37.1	195	0.66	1.30
10	-9.7	-9.7	4.4	4.4	0.399	0.412	0	53.5	48.6	45.8	117	0.94	1.10
20	-11.6	-11.6	4.2	4.2	0.381	0.327	0	58.6	53.4	28.7	204	0.54	1.10
30	-15.3	-15.3	4	4	0.363	0.212	0	33.2	43.8	28.4	117	0.65	0.76
50	-16.5	-16.5	4.9	4.9	0.444	0.193	0	88.6	61.7	33	268	0.53	1.44
70	-21.8	-21.8	4.1	4.1	0.372	0.101	0	131.3	48.6	81	162	1.67	2.70

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
HC VV3 OACHi OACHi

0	7.2	7.2	4.7	4.7	0.436	2.897	0.03	90.2	55.8	56.7	159	1.02	1.62
10	-10	-10	3.9	3.9	0.409	0.357	0.03	53.4	46.2	46	116	1.00	1.16
20	-12.1	-12.1	4.5	4.5	0.499	0.282	0.03	41.3	53.4	26	159	0.49	0.77
30	-15.7	-15.7	3.6	3.6	0.433	0.167	0.03	21.5	45	18.4	117	0.41	0.48
50	-17.9	-17.9	4.6	4.6	0.634	0.129	0.03	108.7	53.4	60.4	180	1.13	2.04
70	-21.9	-21.9	4.1	4.1	0.739	0.065	0.03	37.3	47.4	31.1	120	0.66	0.79

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
HK AHH3 OACHI OACHI

0	5.3	5.3	4.5	4.5	0.419	2.297	0.03	149.1	35.2	216.2	69	6.14	4.24
10	3	3	4.5	4.5	0.422	1.755	0.03	9.6	23.7	45.8	21	1.93	0.41
20	1.1	1.1	3.5	3.5	0.33	1.332	0.03	76.1	37.7	111.8	68	2.97	2.02
30	1.1	1.1	5.4	5.4	0.514	1.473	0.03	17.7	21	88.4	20	4.21	0.84
50	-1.1	-1.1	4.5	4.5	0.431	1.083	0.03	116	52.2	73.9	157	1.42	2.22
70	-4.8	-4.8	4	4	0.393	0.678	0.03	33.7	38.9	51.8	65	1.33	0.87

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
HK AHV0 OACHI OACHI

0	-3.3	-3.3	3.4	3.4	0.308	0.816	0	1.5	14.1	15.3	10	1.09	0.11
10	-6.3	-6.3	6.3	6.4	0.571	0.672	0	2.5	11.1	35.6	7	3.21	0.23
20	-6.1	-6.1	5.6	5.6	0.508	0.663	0	6.4	11.1	90.8	7	8.18	0.58
30	-5.5	-5.5	5.8	5.8	0.526	0.718	0	2.8	11.1	40.3	7	3.63	0.25
40	-7.9	-7.9	3.5	3.5	0.317	0.483	0	68.7	37.7	92.9	74	2.46	1.82
50	-9.8	-9.8	2.7	2.7	0.245	0.373	0	32	26.3	68.1	47	2.59	1.22
60	-10.7	-10.7	5.3	5.3	0.481	0.385	0	4	9.5	67.5	6	7.11	0.42
70	-14.8	-14.8	7	7.1	0.635	0.262	0	2	9.5	32.9	6	3.46	0.21

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
HK AVV0 OACHI OACHI

0	4	4	4.4	4.4	0.399	1.993	0	140.5	41.3	184.9	76	4.48	3.40
5	2.8	2.8	5.3	5.3	0.481	1.83	0	10.1	12.6	67.1	15	5.33	0.80
10	1.1	1.1	6.1	6.2	0.554	1.56	0	14.5	23.7	60.6	24	2.56	0.61
20	0.3	0.3	4.3	4.4	0.394	1.298	0	58.4	43.8	83.5	70	1.91	1.33
25	0.2	0.2	4.7	4.7	0.426	1.303	0	12.1	12.6	121.2	10	9.62	0.96
30	-0.2	-0.2	5.7	5.7	0.514	1.313	0	23.9	23.7	103.8	23	4.38	1.01
40	-1.7	-1.7	4.2	4.2	0.381	1.023	0	47.3	32.7	124.4	38	3.80	1.45
45	-2.6	-2.6	2.4	2.4	0.214	0.834	0	3.5	9.5	58	6	6.11	0.37
50	-3.6	-3.6	0.5	0.5	0.046	0.68	0	8202.6	12.6	6835.5	120	542.50	651.00
70	-5.1	-5.1	3.8	3.8	0.345	0.678	0	57.7	37.7	84.8	68	2.25	1.53

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
HK UHV5 OACHI OACHI

0	1.5	1.5	4.3	4.4	0.427	1.442	0.05	81.6	49.8	47.7	171	0.96	1.64
10	-5.6	-5.6	2.7	2.7	0.278	0.553	0.05	34.8	30.1	48.3	72	1.60	1.16
20	-10.4	-10.4	3.8	3.8	0.447	0.316	0.05	57.6	49.8	33.3	173	0.67	1.16
40	-13.7	-13.7	2	2	0.252	0.179	0.05	36.9	26.3	43.4	85	1.65	1.40
50	-15	-15	3.6	3.6	0.519	0.161	0.05	174	49.8	57.4	303	1.15	3.49
60	-18.2	-18.2	2.8	2.8	0.498	0.09	0.05	4.1	12.6	46	9	3.65	0.33
70	-18.5	-18.5	4.2	4.2	0.85	0.089	0.05	37.4	47.4	23	163	0.49	0.79

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
HK UVV0 OACHi OACHi

0	10.3	10.3	3.8	3.8	0.345	3.991	0	69.1	45	40.2	172	0.89	1.54
10	-2	-2	3.2	3.2	0.29	0.938	0	42.6	36.4	54.6	78	1.50	1.17
20	-3.8	-3.8	3	3	0.272	0.755	0	27.1	41.3	15.8	172	0.38	0.66
30	-5.6	-5.6	4	4	0.363	0.647	0	35.3	38.9	45.2	78	1.16	0.91
40	-12.3	-12.3	1.4	1.4	0.127	0.261	0	2.1	9.5	26.6	8	2.80	0.22
50	-8.6	-8.6	3.3	3.3	0.299	0.441	0	100.7	41.3	45.5	221	1.10	2.44
60	-13.1	-13.1	4.6	4.6	0.417	0.281	0	7	16.9	58	12	3.43	0.41
70	-11.7	-11.7	3.2	3.2	0.29	0.307	0	74.5	42.6	42.1	177	0.99	1.75
80	-20	-20	4	4	0.363	0.123	0	1.7	7.8	34.8	5	4.46	0.22

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
HL HH0 OACHi OACHi

0	6.4	6.4	4.1	4.1	0.372	2.587	0	41.8	46.2	33.2	126	0.72	0.90
10	-8.7	-8.7	4.6	4.6	0.417	0.467	0	29.8	42.6	49.6	60	1.16	0.70
20	-16.5	-16.5	5.5	5.5	0.499	0.199	0	79.4	51	90.3	88	1.77	1.56
30	-22	-22	4	4	0.363	0.098	0	22.1	38.9	36.9	60	0.95	0.57
50	-23.6	-23.6	4.1	4.1	0.372	0.082	0	51.5	48.6	40.3	128	0.83	1.06
70	-30.3	-30.3	3.1	3.1	0.281	0.036	0	38.1	33.9	50.8	75	1.50	1.12

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
HL VV0 OACHi OACHi

0	5.7	5.7	4	4	0.363	2.374	0	33.2	46.2	31.3	106	0.68	0.72
10	-8.4	-8.4	4.9	4.9	0.445	0.491	0	17.9	43.8	29.8	60	0.68	0.41
20	-14.7	-14.7	5.2	5.2	0.472	0.241	0	38.3	51	37.6	102	0.74	0.75
30	-22.1	-22.1	3.6	3.6	0.327	0.095	0	23.7	36.4	40.1	59	1.10	0.65
50	-23.8	-23.8	4.4	4.4	0.399	0.081	0	72	46.2	73.5	98	1.59	1.56
70	-29.5	-29.6	3.5	3.5	0.318	0.04	0	36.8	40.1	40	92	1.00	0.92

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
HS HH3 OACHi OACHi

0	7.4	7.4	3.2	3.2	0.295	2.739	0.03	37.8	40.1	30.3	125	0.76	0.94
10	-9.3	-9.3	3.4	3.4	0.35	0.379	0.03	29.5	36.4	49.1	60	1.35	0.81
20	-13	-13	3.4	3.4	0.376	0.236	0.03	36.8	42.6	29	127	0.68	0.86
30	-17.1	-17.1	3.6	3.6	0.458	0.137	0.03	39.2	38.9	65.3	60	1.68	1.01
50	-19.1	-19.1	4	4	0.575	0.104	0.03	77.7	49.8	46.5	167	0.93	1.56
70	-26.8	-26.8	2.3	2.3	0.785	0.019	0.03	30.1	28.9	27.9	108	0.97	1.04

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHi NormTS N NTS/ TS/
HS HV0 OACHi OACHi

0	-11.1	-11.1	4.5	4.5	0.408	0.352	0	47.7	42.6	67.2	71	1.58	1.12
10	-22.4	-22.4	4.2	4.2	0.381	0.094	0	28	38.9	50.9	55	1.31	0.72
20	-24.5	-24.5	3.7	3.7	0.336	0.072	0	40.3	42.6	38	106	0.89	0.95
30	-27.4	-27.4	3	3	0.272	0.05	0	25.8	32.7	43.8	59	1.34	0.79
50	-29.7	-29.7	3.4	3.4	0.308	0.039	0	78	40.1	67.3	116	1.68	1.95
70	-35.3	-35.3	3	3	0.272	0.02	0	43.8	32.7	51	86	1.56	1.34

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
HS VV0 OACHI OACHI

0	7.5	7.5	3.4	3.4	0.308	2.83	0	29.2	37.7	27.8	105	0.74	0.77
10	-8.8	-8.8	3.3	3.3	0.299	0.431	0	23.1	35.2	38.5	60	1.09	0.66
20	-12.4	-12.4	3.2	3.2	0.29	0.283	0	45.4	37.7	42.5	107	1.13	1.20
30	-16.5	-16.5	3.1	3.1	0.281	0.176	0	21.9	31.4	36.6	60	1.17	0.70
50	-19.8	-19.8	3.1	3.1	0.281	0.12	0	57.7	38.9	47.7	121	1.23	1.48
70	-26	-26	2.1	2.1	0.191	0.056	0	15.7	28.9	14.5	108	0.50	0.54

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
HW HH0 OACHI OACHI

0	4.1	4.1	4.3	4.3	0.39	2.006	0	2.2	7.8	43.2	5	5.54	0.28
40	2.8	2.8	2.4	2.4	0.218	1.565	0	15.9	21	44.3	36	2.11	0.76
60	-0.8	-0.8	4	4	0.359	1.121	0	0.1	7.8	1.8	5	0.23	0.01
70	-3.3	-3.3	3.8	3.8	0.345	0.834	0	0.1	7.8	2.4	5	0.31	0.01

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
HW HV0 OACHI OACHI

35	-5.4	-5.4	1.3	1.3	0.118	0.575	0	2.6	9.5	37.2	7	3.92	0.27
45	-6.1	-6.1	2.6	2.6	0.236	0.567	0	9.6	14.1	79.6	12	5.65	0.68
55	-8.2	-8.2	4	4	0.363	0.479	0	12.3	15.5	94.4	13	6.09	0.79
65	-11.8	-11.8	4.7	4.7	0.426	0.328	0	6.7	16.9	56	12	3.31	0.40
75	-15.8	-15.8	3.8	3.8	0.345	0.198	0	11.4	16.9	71.5	16	4.23	0.67

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
HX HV3 OACHI OACHI

0	-0.8	-0.8	3.1	3.1	0.293	1.041	0.03	2.6	12.6	28.9	9	2.29	0.21
20	-11.9	-11.9	2.3	2.3	0.243	0.256	0.03	13.4	28.9	19.4	69	0.67	0.46
30	-14.7	-14.7	3.4	3.4	0.394	0.189	0.03	9.9	23.7	49.6	20	2.09	0.42
40	-13.8	-13.8	2.7	2.7	0.3	0.204	0.03	46.9	25	104.3	45	4.17	1.88
50	-17.4	-17.4	2.3	2.3	0.284	0.121	0.03	22.7	32.7	18.9	120	0.58	0.69
70	-22.2	-22.2	2.8	2.8	0.479	0.058	0.03	32.6	33.9	45.9	71	1.35	0.96

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
HX VV5 OACHI OACHI

0	9.3	9.3	3.7	3.7	0.344	3.487	0.05	36.1	36.4	49.4	73	1.36	0.99
10	-3.8	-3.8	2.6	2.6	0.261	0.689	0.05	16.2	26.3	56	29	2.13	0.62
20	-5.3	-5.3	2.6	2.6	0.266	0.571	0.05	23.6	32.7	31.9	74	0.98	0.72
30	-9.8	-9.8	2.6	2.6	0.291	0.32	0.05	8.2	23.7	29.4	28	1.24	0.35
40	-11.8	-11.8	2.9	2.9	0.348	0.248	0.05	7.4	15.5	57.1	13	3.68	0.48
50	-12.6	-12.6	2.4	2.4	0.293	0.215	0.05	22.2	30.1	24.1	92	0.80	0.74
60	-15	-15	4.4	4.4	0.659	0.168	0.05	9.1	18.3	60.8	15	3.32	0.50
70	-16.3	-16.3	3	3	0.458	0.127	0.05	52	37.7	66.7	78	1.77	1.38
80	-22.8	-22.8	4.2	4.2	1.985	0.018	0.05	4.7	11.1	52	9	4.68	0.42

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OAChi NormTS N NTS/ TS/
IK AHH3 OACHI OACHI

0	3.6	3.6	6.4	6.4	0.607	2.083	0.03	53	47.4	110.4	48	2.33	1.12
10	-2.7	-2.7	8.6	8.6	0.884	1.116	0.03	13.8	23.7	69.1	20	2.92	0.58
25	-5	-5	8.7	8.7	0.926	0.851	0.03	4.3	14.1	43.2	10	3.06	0.30
30	-4.4	-4.4	9.7	9.7	1.045	0.964	0.03	19.7	25	98.3	20	3.93	0.79
50	-8.5	-8.5	8.2	8.2	0.922	0.541	0.03	85.4	74.5	74.9	114	1.01	1.15
70	-9.8	-9.8	8.3	8.3	0.966	0.461	0.03	51.5	48.6	103	50	2.12	1.06

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IK AHV0 OACHI OACHI

0	-17.5	-17.5	10	10.1	0.907	0.225	0	11.6	14.1	128.8	9	9.13	0.82
10	-26.5	-26.5	5.4	5.4	0.49	0.063	0	1.9	7.8	38.7	5	4.96	0.24
20	-25.6	-25.6	3.7	3.7	0.336	0.064	0	2	9.5	33	6	3.47	0.21
50	-27.6	-27.6	1.8	1.8	0.163	0.046	0	10.1	16.9	34.8	29	2.06	0.60
60	-31.6	-31.6	1.8	1.8	0.163	0.029	0	4.4	7.8	72.7	6	9.32	0.56
80	-39.6	-39.6	6.8	6.9	0.617	0.015	0	0	-1	0	3	0.00	0.00

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IK UHV3 OACHI OACHI

0	2.4	2.4	4.8	4.8	0.452	1.662	0.03	121.2	52.2	68.8	176	1.32	2.32
10	-6.9	-6.9	4	4	0.402	0.526	0.03	57.7	40.1	68.6	84	1.71	1.44
20	-12.9	-12.9	5.2	5.2	0.601	0.264	0.03	103.7	55.8	52.6	197	0.94	1.86
30	-16.2	-16.2	6.1	6.1	0.817	0.177	0.03	215	43.8	238.9	90	5.45	4.91
50	-19.2	-19.2	6.4	6.4	1.044	0.113	0.03	126.9	68.7	45.6	278	0.66	1.85
70	-20.4	-20.4	5.8	5.8	1.007	0.09	0.03	49.7	62.8	28.7	173	0.46	0.79

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IK UVV3 OACHI OACHI

0	8.5	8.5	5	5	0.463	3.423	0.03	117.4	52.2	69.9	168	1.34	2.25
10	-3.2	-3.2	4.2	4.2	0.407	0.83	0.03	58.1	42.6	63.9	91	1.50	1.36
20	-6.6	-6.6	4.7	4.7	0.475	0.566	0.03	58.2	51	33.8	172	0.66	1.14
30	-7.5	-7.5	5.2	5.2	0.536	0.522	0.03	52	46.2	57.7	90	1.25	1.13
50	-11.2	-11.2	4.9	4.9	0.538	0.324	0.03	71	56.9	34	209	0.60	1.25
70	-13.2	-13.2	3.9	3.9	0.438	0.237	0.03	45.7	48.6	27.5	166	0.57	0.94

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IW HV0 OACHI OACHI

0	-3.2	-3.2	5.5	5.5	0.499	0.922	0	4.1	12.6	45.1	9	3.58	0.33
10	-9.3	-9.3	2.1	2.1	0.19	0.382	0	3.3	11.1	36.4	9	3.28	0.30
20	-9.8	-9.8	2.4	2.4	0.218	0.367	0	5.7	11.1	63.5	9	5.72	0.51
30	-10.1	-10.1	2.5	2.5	0.227	0.356	0	4.6	11.1	50.8	9	4.58	0.41
50	-13.5	-13.5	4.3	4.3	0.39	0.264	0	0.9	15.5	7.1	12	0.46	0.06
60	-15.4	-15.4	5.4	5.4	0.49	0.225	0	4.7	16.9	38.9	12	2.30	0.28

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IW VV0 OACHI OACHI

0	0.2	0.2	5.7	5.8	0.518	1.378	0	0.8	12.6	8.3	10	0.66	0.06
5	-7.3	-7.3	2.5	2.5	0.227	0.492	0	3.3	12.6	33.3	10	2.64	0.26
10	-6.9	-6.9	3	3	0.272	0.528	0	7.4	14.1	67.4	11	4.78	0.52
20	-7.2	-7.2	3.3	3.3	0.299	0.518	0	6.4	15.5	46	14	2.97	0.41
30	-8.7	-8.7	3.7	3.7	0.336	0.445	0	3.9	16.9	28	14	1.66	0.23
35	-10.2	-10.2	2.5	2.5	0.227	0.352	0	9.3	15.5	71.6	13	4.62	0.60
45	-10.7	-10.7	3.8	3.8	0.345	0.356	0	17.3	22.4	91.1	19	4.07	0.77
50	-11	-11	3.2	3.2	0.29	0.333	0	7.5	15.5	57.5	13	3.71	0.48
55	-12.4	-12.4	2.9	2.9	0.263	0.279	0	12	21	60.2	20	2.87	0.57
60	-14.2	-14.2	3.4	3.4	0.308	0.233	0	4	15.5	30.8	13	1.99	0.26
65	-15.4	-15.4	1.8	1.8	0.163	0.186	0	7.5	16.9	53.5	14	3.17	0.44
75	-18	-18	5.3	5.3	0.481	0.166	0	19	21	86.3	22	4.11	0.90

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IX HH3 OACHI OACHI

0	3.5	3.5	3.9	3.9	0.364	1.802	0.03	1410.9	41.3	1396.9	101	33.82	34.16
10	-7.6	-7.6	3.9	3.9	0.395	0.48	0.03	78.9	33.9	213.1	37	6.29	2.33
20	-10.6	-10.6	3.4	3.4	0.357	0.322	0.03	40.6	43.8	36.5	111	0.83	0.93
30	-15.2	-15.2	3.4	3.4	0.4	0.176	0.03	21.8	31.4	60.5	36	1.93	0.69
40	-17	-17	3.6	3.6	0.456	0.139	0.03	16.8	33.9	44.3	38	1.31	0.50
50	-18	-18	3.4	3.4	0.448	0.119	0.03	62.1	47.4	26.3	236	0.55	1.31
60	-21.8	-21.8	5.4	5.4	1.039	0.069	0.03	15.3	21	95.9	16	4.57	0.73
70	-20	-20	4.3	4.3	0.665	0.092	0.03	29.8	47.4	34.3	87	0.72	0.63

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IX HV3 OACHI OACHI

0	0.9	0.9	3	2.9	0.273	1.262	0.03	33.6	30.1	62.3	54	2.07	1.12
10	-12.6	-12.6	2	2	0.213	0.23	0.03	8.6	16.9	43.1	20	2.55	0.51
20	-15.5	-15.5	3.3	3.3	0.391	0.168	0.03	36.2	36.4	45.9	79	1.26	0.99
30	-18.2	-18.2	2.1	2.1	0.266	0.107	0.03	11.3	22.4	41.7	27	1.86	0.50
40	-23.3	-23.3	2.5	2.5	0.467	0.047	0.03	22.7	25	78.3	29	3.13	0.91
50	-22.5	-22.5	3.5	3.5	0.644	0.057	0.03	39.6	41.3	32.7	121	0.79	0.96
60	-26.7	-26.7	4.8	4.8	2	0.014	0.03	2.2	11.1	27.3	8	2.46	0.20
70	-24.2	-24.2	4.1	4.1	0.976	0.04	0.03	52.6	40.1	69.2	76	1.73	1.31

IA Mean ResMean StD ResStD Alpha Beta Gamma TstStat OACHI NormTS N NTS/ TS/
IX VV3 OACHI OACHI

0	2.8	2.8	3.7	3.7	0.346	1.643	0.03	983.4	37.7	1385.1	71	36.74	26.08
10	-6.9	-6.9	4.1	4.1	0.412	0.529	0.03	74.9	30.1	214.1	35	7.11	2.49
20	-9.4	-9.4	4.4	4.4	0.461	0.395	0.03	59.3	43.8	81.2	73	1.85	1.35
30	-14.8	-14.8	3.6	3.6	0.421	0.188	0.03	26.4	32.7	80	33	2.45	0.81
40	-18.7	-18.7	4.4	4.4	0.629	0.113	0.03	4.5	18.3	34.7	13	1.90	0.25
50	-16.4	-16.4	3.9	3.9	0.487	0.154	0.03	28.8	43.8	28.5	101	0.65	0.66
60	-20.1	-20.1	6.1	6.1	1.049	0.096	0.03	11.1	21	74.2	15	3.53	0.53
70	-18.8	-18.8	4.2	4.2	0.599	0.11	0.03	35.4	47.4	46	77	0.97	0.75

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Vita

Second Lieutenant Ricardo Mediavilla was born on 8 April 1974 in Santurce, Puerto Rico. He graduated from Dr. José M. Lázaro High School in Carolina, Puerto Rico in May 1992. He entered undergraduate studies at the University of Puerto Rico, Mayaguez Campus where he graduated Magna Cum Laude with a Bachelor of Science degree in Electrical Engineering in June 1997. He was commissioned through the Detachment 755-A AFROTC at the Mayaguez Campus of the University of Puerto Rico. Lt. Mediavilla was accepted to AFIT after completing his undergraduate studies.

Lt. Mediavilla married Paola Chardon on 26 of December 1998. Upon graduation, Lt. and Mrs. Mediavilla will move to Utah. Lt Mediavilla has been assigned to the Radar Evaluation Squadron (RADES/TOE), Hill AFB, Utah.

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