RELATIONSHIP BETWEEN GOLD AND OIL PRICE – AN ECONOMETRIC ANALYSIS

A DISSERTATION REPORT

Submitted by

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CERTIFICATE

This is to certify that this project report entitled **"RELATIONSHIP BETWEEN GOLD AND OIL PRICE – AN ECONOMETRIC ANALYSIS"** is the bonafide work of **"APARAJITA KUMARI"** in partial fulfillment for the 4th semester in MS OIL TRADING of the University of Petroleum & Energy Studies during the year 2005-07. It is certified that all corrections indicated for the internal assessment have been incorporated in the report deposited in the library. The dissertation report has been approved as it satisfies the academic requirements in respect of dissertation work prescribed for the MS Degree.

SIGNATURE

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APARAJITA KUMARI.

ABSTRACT

Crude oil prices have witnessed sustained volatility since Gulf crisis of 1990. This fluctuation in prices has rocked a large number of countries including India, which imports over 70% of its domestic requirements. The idea that the oil price is an important driver of the gold price has also been given weight by the commentaries of the many gold bugs who, over recent years, have often cited the rising oil price as a reason to expect a higher gold price.

Gold is unfortunately not money right now, but in many respects it still trades as if it were. For example, it typically turns in its best performances when real economic growth and confidence are falling. Changes in the oil price are neither here nor there as far as the price of gold bullion is concerned. Under the current monetary system the directions of the long-term price trends in oil and gold will tend to be the same or may constantly change because inflation is a primary driver of both markets along with price of dollar. Is it what's happening on the monetary front or with oil supply/demand , that matters to the gold market or vice versa ? ?

Changes in the oil price do, however, have an important effect on gold mining shares, but it's not the effect that most people would expect. To be specific, as far as gold mining equities are concerned a rise in the oil price is BEARISH and a fall in the oil price is BULLISH. One reason as analyzed by experts is that gold miners are major CONSUMERS of oil (a large chunk of a gold miner's costs are energy-related). Similarly there are many more reasons quoted by analysts and experts.

The project is an attempt to study the price trend of crude oil and gold and trying to establish relationship between crude oil and gold.

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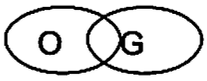
CHAPTER 1

INTRODUCTION

Oil producers normally find it in their best interest to add steadily to productive capacity. Gradual addition of capacity year after year keeps oil supply in rough equilibrium with demand as the global economy grows. Mild shortages and surpluses sometimes arise, but they are quickly addressed by market forces so long as monetary policy is anchored properly. It was really a monetary error that began throwing the oil market out of whack three years ago. Specifically, it was the sharp deflation of the U.S. dollar which began in 1997-98. As the value of the dollar rose into deflationary territory -- as measured against gold, the best proxy for commodities, many countries were forced to break their dollar links and devalue their currencies. This triggered major global disruption, first in Asia and then in Latin America.

As global economy slowed, oil demand plunged, leaving an excess of oil on the market, which caused oil to fall harder and faster than gold or the currencies tracing the dollar. As the oil price fell to $10/bbl in 1998/99, oil producers at the margin were driven out of business. Those that remained stopped investing in infrastructure and production. Once the world economy adjusted to the deflation, in 1999, global growth resumed. Governments in Asia and Latin American began to find the keys to growth, stabilizing their currencies and jettisoning some of the austere fiscal policies pressed upon them by the IMF and World Bank. The rebound in commerce quickly increased the need for oil. Demand began to exceed available inventories, pushing prices up and out of their



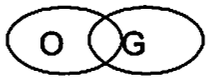
traditional trading locus. Had oil producers at the margin not been totally destroyed by the 1997-98 commodity depression, no supply shortages would have emerged.

1.1 OIL PRICE HISTORY

Crude oil prices behave much as any other commodity with wide price swings in times of shortage or oversupply. The crude oil price cycle may extend over several years responding to changes in demand as well as OPEC and non-OPEC supply. The U.S. petroleum industry's price has been heavily regulated through production or price controls throughout much of the twentieth century. In the post World War II era U.S. oil prices at the wellhead have averaged $23.57 per barrel adjusted for inflation to 2006 dollars. In the absence of price controls the U.S. price would have tracked the world price averaging $25.56. Over the same post war period the median for the domestic and the adjusted world price of crude oil was $18.43 in 2006 prices. That means that only fifty percent of the time from 1947 to 2006 have oil prices exceeded $18.43 per barrel. Until the March 28, 2000 adoption of the $22-$28 price band for the OPEC basket of crude, oil prices only exceeded $23.00 per barrel in response to war or conflict in the Middle East.

Post World War II : Pre Embargo Period

Crude Oil prices ranged between $2.50 and $3.00 from 1948 through the end of the 1960s. The price oil rose from $2.50 in 1948 to about $3.00 in 1957. When viewed in 2004 dollars an entirely different story emerges with crude oil prices fluctuating between $15 - $17 during the same period. The apparent 20% price increase was just keeping up with inflation. From 1958 to 1970 prices were stable at about $3.00 per barrel, but in real terms the price of crude oil declined from above $16 to below $13 per barrel. The

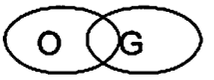


decline in the price of crude when adjusted for inflation was amplified for the international producer in 1971 and 1972 the weakness of the US dollar. OPEC was formed in 1960 with five founding members Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. By the end of 1971 six other nations had joined the group: Qatar, Indonesia, Libya, United Arab Emirates, Algeria and Nigeria. From the foundation of the Organization of Petroleum Exporting Countries through 1972 member countries experienced steady decline in the purchasing power of a barrel of oil.

Throughout the post war period exporting countries found increasing demand for their crude oil but a 40% decline in the purchasing power of a barrel of crude. In March 1971, the balance of power shifted. That month the Texas Railroad Commission set proration at 100 percent for the first time. This meant that Texas producers were no longer limited in the amount of oil that they could produce. More importantly, it meant that the power to control crude oil prices shifted from the United States (Texas, Oklahoma and Louisiana) to OPEC. A little over two years later OPEC would through the unintended consequence of war get a glimpse at the extent of its ability to influence prices.

1.2 MIDDLE EAST SUPPLY INTERRUPTIONS

In 1972 the price of crude oil was about $3.00 per barrel and by the end of 1974 the price of oil had quadrupled to over $12.00. The Yom Kippur War started with an attack on Israel by Syria and Egypt on October 5, 1973. The United States and many countries in the western world showed strong support for Israel. As a result of this support several Arab exporting nations imposed an embargo on the countries supporting Israel. Arab nations curtailed production by 5 million barrels per day (MMBPD) about 1 MMBPD



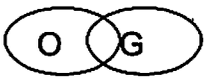
was made up by increased production in other countries. The net loss of 4 MMBPD extended through March of 1974 and represented 7 percent of the free world production. If there was any doubt that the ability to control crude oil prices had passed from the United States to OPEC it was removed during the Arab Oil Embargo. The extreme sensitivity of prices to supply shortages became all too apparent when prices increased 400 percent in six short months.

From 1974 to 1978 world crude oil prices were relatively flat ranging from $12.21 per barrel to $13.55 per barrel. When adjusted for inflation the price over that period of time exhibited a moderate decline.

1.3 CRISES IN IRAN AND IRAQ

Events in Iran and Iraq led to another round of crude oil price increases in 1979 and 1980. The Iranian revolution resulted in the loss of 2 to 2.5 million barrels of oil per day between November, 1978 and June, 1979. At one point production almost halted. Iraq invaded Iran in September, 1980 by November the combined production of both countries was only a million barrels per day and 6.5 million barrels per day less than a year before. Worldwide crude oil production was 10 percent lower than in 1979. The combination of the Iranian revolution and the Iraq/Iran War resulted in crude oil prices more than doubling from $14 in 1978 to $35 per barrel in 1981. Twenty-five years later Iran's production is only two-thirds of the level reached under the government of Reza Pahlavi the former Shah of Iran.

The oil price should come back down as high prices pull capital towards higher relative returns, which implies more production -- but the process will take a while. The 1997/98

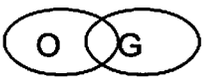


oil price plunge had a searing effect on producers, who obviously do not want to be burned again, should another deflation be right around the corner. Oil producers may not have identified price swings as monetary deflation, but they certainly grasped the concept that committing to new fixed capacity is *more risky* in an environment where the *nominal* price is highly volatile. As long as the dollar is not fixed in terms of gold, its volatility will continue to throw off misleading signals of capital shortages and surpluses, inevitably leading to booms and busts.

Gold and oil traditionally have had a 15-to-1 relationship, only slipping out of congruence for short periods of time. When the gold/dollar relationship is anchored, the oil/dollar relationship remains stable as well. When the dollar/gold relationship is malfunctioning, as it is now, capital is wasted as producers try to protect themselves from the damaging impact of inflations and deflations, which ultimately weaken the entire pricing system.

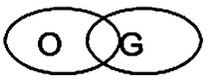
Global oil demand is growing rapidly, and projected to keep growing dramatically for the next decade. China and India alone, representing over a third of the population of the planet, are industrializing rapidly and will need vast amounts of oil to fuel each of their billion people plus population economies. Global oil supply in production is stagnant. Low oil prices in recent years, coupled with capital enamored with promiscuously chasing dot com type debacles has left oil production infrastructure in deteriorating conditions. In addition, existing wells have been pumping for many years, often with artificially increased production levels through techniques such as salt water injection. Artificially stimulated wells tend to rapidly drop off in production when they near the end

of their useful lives. Many of the major oil reserves in the western world are nearing the end of their expected lives at present production levels. Although many other large reserves exist which will be tapped, logistical realities and political hoops indicate it will take many years to bring these reserves online. It takes time to drill wells, set up transportation infrastructure, and bring new mega-well facilities to a live state. Political maneuvering, such as the ban in drilling off certain areas of California and the present US administration's staunch resistance to opening up vast Alaskan reserves makes rapid increases in marketable supply in the western world unlikely. In the east, geopolitical problems limit new marketable supply as well. Vast reserves exist in the landlocked Caspian Sea, but they are surrounded by those paragon nations of peace and stability including Russia, Chechnya, Azerbaijan, Kazakhstan, Turkmenistan, and Iran. For many years western and eastern nations have been arguing over where to lay a pipeline from Baku on the Caspian, but no agreement can be reached. The US wants the pipeline to go through Turkey, which means it would have to go through the warzone in Chechnya. Iran wants it to run through Iran. (Iran has also offered to swap oil, filling western tankers with Persian Gulf oil in exchange for western Caspian Sea oil delivered to northern Iran.) Bottom line, it is a political mess that will not resolve itself overnight just because oil prices are rising. Many brilliant petroleum analysts believe OPEC is operating at levels over 95% of maximum production. Only Saudi Arabia is thought to have significant capacity left, and even the Saudis have not upgraded oil infrastructure sufficiently due to the increasing cost of their domestic social problems. Lots more oil is NOT coming from OPEC for a long time, regardless of political grandstanding in the west.



If another war breaks out in the Middle East, oil is going stratospheric. The region, as always, is rife with tensions. Iraq hates Iran. Kuwait and Saudi Arabia fear both Iran and Iraq. Syria loathes Turkey. Everyone in the region except Turkey would like to drive Israel into the sea and retake Jerusalem and the Dome of the Rock (the third most holy site in Islam). Israel now has nuclear tipped submarine launched cruise missiles to deter ballistic missile strikes from the Arabs. The whole region is a powder keg, waiting for an inherently unpredictable and errant spark. As an added bonus, Iran is currently heavily fortifying the small island of Abu Musa, which is one of the most important strategic islands on the planet. Whoever controls Abu Musa exercises unilateral hegemony over all the oil in the Persian Gulf, as Abu Musa is the "cork" which bottles up the gulf. If supertankers (the ultimate targets of opportunity in war, as one's enemies can't fight without oil) can't get out of the gulf, crude oil prices will reach heights that are unfathomable today.

From 1946-1971, gold and oil prices were flat lined. This lack of price volatility in oil was a great asset to the booming post WWII US industrial economy. Oil price volatility greatly complicates strategic industrial planning, and increases risk aversion to new ventures heavily dependent on crude prices. From 1972-2000, however, gold and oil prices look like an electro-cardiogram of a hamster on speed. With Nixon's fateful decision to sever the critical link between the US dollar and gold in 1971, all semblance of discipline in fiat currency growth was forever vanquished. The wild gyrations on the right side of the graph are the direct result of the lack of prudent restraint of fiat currency growth. The second critical theme to note is the recent divergence of the correlation numbers. From 1946-1994, gold and crude oil had a very high positive correlation of



0.92. The correlation is highly logical, as gold and crude have almost always both performed extremely well in periods of inflation, as they are both REAL assets that always appreciate in fiat currency terms over the long run. From 1995-2000, however, strange things are apparently afoot in the gold and crude relationship. The correlation drops to an unbelievable 0.07.

In 1995, for some reason, the US Federal Reserve embarked on an unprecedented binge of M3 growth. Shortly after the famous "Irrational Exuberance in US Equity Markets" speech given by Chairman Greenspan, the Fed chose to open the blowout valves and unleash a deluge of liquidity into the US economy. Like rain from a hurricane, all the new fiat dollars had to go somewhere, and the destination of choice was the already overvalued US equity markets. The phenomenal exponential growth of the S&P 500 following the massive goosing of M3 is very evident in the graph. Money available in an economy and stock market valuations have generally been strongly positively correlated all throughout history, in many different countries. In the US, M3 and the S&P had a 0.92 correlation between 1959 and 1994. That correlation shot up to an incredible 0.99

Gold has been the most sensitive barometer imaginable to inflation, throughout all of human history. As the proverbial canary in the fiat coal mine, gold always announces fiat currency problems (inflation, or debasement as it was called in the past) in advance by rising dramatically in value. Many brilliant analysts, including the Gold Anti-Trust Action Committee, have hypothesized that the US government began operations in 1995 to suppress the price of gold. By artificially capping the gold price in US dollars, the world financial community would be blinded to the reckless growth in US money supply

and inflation numbers, and be deluded into thinking the US economy was in far better shape than M3 growth alone would suggest. The alleged methodologies used by the government in suppressing the gold market include selling gold derivatives contracts in the open market, persuading other central banks to loan or sell physical gold into the market, and commissioning certain key money center bullion banks to cap fledgling gold rallies. Adjusted for inflation, even $30 oil seems cheap relative to the early 1980s. In terms of today's dollars, gold was trading at over $1,500 per ounce in the 80s. Prior to 1971, in real terms, even the price of oil was declining, obviously very healthy for the US economy. The consequences of the fateful fiat decision in 1971 are even more apparent when viewed from a real perspective. The last few years of the chart are also most interesting. Generally, over the last 55 years, gold and oil have moved in close sympathy.

1.4 Gold

Among all precious metals, gold's appeal is legendary. Since the beginning of time, gold has propelled the growth of empires, the birth of nations and the evolution of the world's financial institutions. We can attribute the enduring influence and intrigue of gold. The desire of gold is not for gold. It is for the means of freedom and benefit.

Virtually indestructible, highly malleable, ductile and impervious to tarnishing, gold is among the most beautiful and useful elements in the world. Gold can be hammered into sheets so thin that light can pass through, and a single ounce can be drawn into a wire fifty miles long. Gold artifacts and coins buried thousands

of years ago, when unearthed, look as lustrous as the day they were created. Gold's chemical and physical properties have long made it coveted by artisans and industry alike. But above its utility to craftsmen and industrialists, gold has been most revered as a form of currency.

People typically have not sought or owned gold for gold's sake, but for what it represents. Above its aesthetic and monetary worth, gold imparts autonomy. It offers freedom from unpredictability, from a haunting fear of the unknown. Its value has weathered centuries fraught with political upheaval, economic turmoil and inconceivable cataclysmic events. Commonly accepted in many parts of the world as payment, gold is perhaps the most lasting and trustworthy store of financial value known to man.

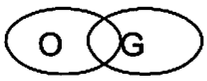
i) It is merely a yellow material that we happen to use a lot for coins, jewelry, and dentures. It can be adequately defined as a dense, lustrous, precious metal that is an element, Group Ib.

ii) It is money, lucre, wealth, something to hoard.

iii) It is a sacred substance, symbolizing the sun and possessing the power to purify.

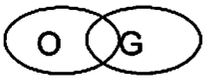
iv) Goldsmiths and artisans around the world esteem it as the most beautiful and desirable of metals; warm and glowing, malleable, ductile. Its permanence, its durability and resistance to corrosion immortalizes their labor.

v)But other the these it is also a commodity, a Costly raw material with a fluctuating price that often serves merely as a vehicle for easy profit.



The flow of gold throughout history has caused us to be obsessed, intoxicated, inspired, and exalted. It has, from the beginning of history, been a dream, a myth, a symbol of something beyond itself.

In "The Power of Gold" The History of an Obsession, economist Peter L. Bernstein recounts how it has, for 3000 years, excited and motivated peoples and cultures, determined the fates of leaders, destroyed economies, prompted inhuman acts, and "driven people to intense hardship in the hope of finding instant wealth beyond all sense of rationality. " In the end, he says "Gold has stirred the passions for power and glory, for beauty, for security, and even immortality. Gold has been an icon for greed, a vehicle for vanity and a potent constraint as a monetary standard" and notes that no other substance "has commanded so much veneration over so long a period of time." While gold's mystique is indisputable, we must resist being so entranced by its luster that we fail to recognize and consider the realities of gold at the beginning of the twenty-first century. The ecologic, economic, social, and political price of gold is far costlier that we imagine. We are in the midst of a new gold rush, one that is consuming wilderness areas, contaminating watersheds, destroying ecosystems, and imperiling the economies of poor nations and the well- being of indigenous people throughout the world. Some cumulative, irreparable consequences of mining will be with us, in this country and around the world, forever. This new gold rush is the result of a converging complexity of circumstances on a global scale



1.5 HISTORY OF GOLD

Gold has been known and highly valued since prehistoric times. It may have been the first metal used by humans and was valued for ornamentation and rituals. Egyptian hieroglyphs from as early as 2600 BC describe gold, which king Tushratta of the Mitanni claimed was "more plentiful than dirt" in Egypt. Egypt and Nubia had the resources to make them major gold-producing areas for much of history. Gold is also mentioned several times in the Old Testament, and is included with the gifts of the magi in the first chapters of Matthew New Testament The south-east corner of the Black Sea was famed for its gold. Exploitation is said to date from the time of Midas, and this gold was important in the establishment of what is probably the world's earliest coinage in Lydia between 643 and 630 BC.

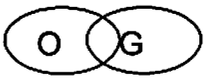
The European exploration of the Americas was fueled in no small part by reports of the gold ornaments displayed in great profusion by Native American peoples, especially in Central America, Peru, and Colombia. Although the price of some platinum group metals can be much higher, gold has long been considered the most desirable of precious metals, and its value has been used as the standard for many currencies (known as the gold standard) in history. Gold has been used as a symbol for purity, value, royalty, and particularly roles that combine these properties. Gold as a sign of wealth and prestige was made fun of by Thomas More in his treatise Utopia. On that imaginary island, gold is so abundant that it is used to make chains for slaves, tableware and lavatory-seats. When ambassadors from other countries arrive, dressed in ostentatious gold jewels and badges, the Utopians mistake them for menial servants, paying homage instead to the most modestly-dressed of their party. There is an age-old tradition of biting gold in order to

test its authenticity. Although this is certainly not a professional way of examining gold, the bite test should score the gold because gold is considered a soft metal according to the Mohs' scale of mineral hardness. The purer the gold the easier it should be to mark it. Painted lead can cheat this test because lead is softer than gold (and may invite a small risk of lead poisoning if sufficient lead is absorbed by the biting).

This 156 ounce nugget was found by an individual prospector in the Southern California Desert using a metal detector. Gold in antiquity was relatively easy to obtain geologically; however, 75% of all gold ever produced has been extracted since 1910. It has been estimated that all the gold in the world that has ever been refined would form a single cube 20 m (66 ft) on a side (8000 m^3).

The primary goal of the alchemists was to produce gold from other substances, such as lead — presumably by the interaction with a mythical substance called the philosopher's stone. Although they never succeeded in this attempt, the alchemists promoted an interest in what can be done with substances, and this laid a foundation for today's chemistry. Their symbol for gold was the circle with a point at its center, which was also the astrological symbol, the Egyptian hieroglyph and the ancient Chinese character for the Sun . For modern attempts to produce artificial gold, see gold synthesis.

During the 19th century, gold rushes occurred whenever large gold deposits were discovered. The first major gold strike in the United States occurred in a small north Georgia town called Dahlonega. Further gold rushes occurred in California, Colorado, Otago, Australia, Witwatersrand, Black Hills, and Klondike. Because of its historically



high value, much of the gold mined throughout history is still in circulation in one form or another.

Gold is a chemical element with the symbol Au (from the Latin aurum) and atomic number 79. It is a highly sought-after precious metal which, for many centuries, has been used as money, a store of value and in jewelry. The metal occurs as nuggets or grains in rocks, underground "veins" and in alluvial deposits. It is one of the coinage metals. It is a dense, soft, shiny, yellow metal, and is the most malleable and ductile of the known metals.

Gold forms the basis for a monetary standard used by the International Monetary Fund (IMF) and the Bank for International Settlements (BIS). Its ISO currency code is XAU. Modern industrial uses include dentistry and electronics, where gold has traditionally found use because of its good resistance to oxidative corrosion.

Gold is the most malleable and ductile metal; a single gram can be beaten into a sheet of one square meter, or an ounce into 300 square feet. Gold readily forms alloys with many other metals. These alloys can be produced to increase the hardness or to create exotic colors. Adding copper yields a redder metal, iron blue, aluminium purple, platinum white, and natural bismuth and silver alloys produce black. Native gold contains usually eight to ten percent silver, but often much more — alloys with a silver content over 20% are called electrum. As the amount of silver increases, the color becomes whiter and the specific gravity becomes lower.

Gold is a good conductor of heat and electricity, and is not affected by air and most reagents. Heat, moisture, oxygen, and most corrosive agents have very little chemical effect on gold, making it well-suited for use in coins and jewelry; conversely, halogens

will chemically alter gold, and aqua regia dissolves it by virtue of the elemental chlorine generated by this acid mixture. Common oxidation states of gold include +1 (gold (I) or aurous compounds) and +3 (gold(III) or auric compounds). Gold ions in solution are readily reduced and precipitated out as gold metal by adding any other metal as the reducing agent. The added metal is oxidized and dissolves allowing the gold to be displaced from solution and be recovered as a solid precipitate. Recent research undertaken by Sir Frank Reith of the Australian National University shows that microbes play an important role in forming gold deposits, transporting and precipitating gold to form grains and nuggets that collect in alluvial deposits.

High quality pure metallic gold is tasteless; in keeping with its resistance to corrosion (it is metal ions which confer taste to metals). In addition, gold is very dense, a cubic meter weighing 19300 kg. By comparison, the density of lead is 11340 kg/m3, and the densest element, Iridium, is 22650 kg/m3.

CHAPTER 2

REVIEW OF LITERATURE

In the journal author Vaughan Leighton had presented report titled - **"Information Efficiency in Financial and Betting Markets"** in year 2005 . In the report the author analyzed that the bilateral relationship of Co-moving Commodity in the is not present in market For example, the concordance between oil and Gold .The econometric analysis was then conducted on that.

Another study was done on "**A Monetary Explanation of Oil And Gold Prices**" in year 2000. Study reveal the effect of inflation on oil and gold prices in the post-war period, the paper presents a monetary explanation of oil and gold pricing through a cash-in-advance economy.

Importance of oil price on gold price behavior was studied in year 2006 in the report **"The Gold And Oil Relationship".** The idea that the oil price is an important driver of the gold price has also been given weight by the commentaries of the many gold bugs who, over recent years, have often cited the rising oil price as a reason to expect a higher gold price.

Gillman and Nakov in year 2005 had made research on " Relationship between oil and gold" .The research says that the "price of oil is poised to rise steadily as the supply/demand imbalance increases and the dollar declines, even if there are no supply disruptions, terrorist threats or geopolitical concerns to consider. As this happens, the price of precious metals will climb until they eventually catch up to their historic ratios."

In year 2006 a paper was published on **"The Gold and Oil Relationship".** This paper presents the idea that the oil price is an important driver of the gold price has also been given weight by the commentaries of the many gold bugs who, over recent years, have often cited the rising oil price as a reason to expect a higher gold price

Sabin(1900-1940) **" The California Oil Market"**

"Why we are never going to see $40 a barrel again. Energy shortages, climate change, and the debate over national security have thrust oil policy to the forefront of American politics. How did Americans grow so dependent on petroleum, and what can we learn from our history."

Johnson (2006) " The Truth about Oil"

"According to the Energy Information Administration (a bureau of the Department of Energy), the daily global consumption of crude oil has climbed by 22% in the past 16 years; however, the price of crude has increased nearly eightfold. Gasoline demand in the same period is up about 44%, while the traded futures price of gasoline has increased sixfold. Clearly, the amount by which the price has risen seems to exceed the degree by which demand has grown."

Deaf (2003) **"The Gold Rust"**

"Briefly discusses the events surrounding the nineteenth-century gold rush in California, using first-hand accounts."

Gaikwad(2006) and Valley(2006) **"Bubble, Bubble, Who's in Trouble?"**

"The authors have put their ideas in a nice and lucid manner. The book progresses from analysis to possible strategies to counter Oil crisis using their Oil Indicator. (One personal recommendation... start the book from last chapter and progress towards the 1st chapter in reverse. You will better understand and appreciate what the authors are recommending and why they are recommending). The chapters have been written in perfect bite sizes. I liked the summary of the chapter in the key point's format"

David Goodstein (2004). **The End of the Age of Oil**

" Explains with limited jargon how we could potentially exhaust our cheap, conventionally produced oil supplies. Possibly within the next 10 years. Additionally, Goodstein also explores the likely consequences it he is correct. The New York Times Book review named Out of Gas: The End of the Age of Oil as one of its 100 Notable Books."

CHAPTER 3

OBJECTIVE SCOPE AND LIMITATIONS OF THE STUDY

3.1 OBJECTIVES OF STUDY

The research aims to achieve the following objectives:

- To study the trend in Crude Oil and Gold prices
- To establish Relationship between Crude Oil and Gold prices
- Try to know that what are the main reason why the relationship exist

3.2 SCOPE OF STUDY

The research limits the analysis of crude oil and gold prices to the period 2000-2006. The study uses only select econometrics tools. Monthly WTI Crude and London Gold prices used in this study as data. This research work is not prescriptive in nature.

3.3 LIMITATIONS OF THE STUDY

Analysis on the relationship between gold and crude oil will be based on the historical data and historical data may not always present the true picture of future trend. Also the key factors to the strong relationship between crude oil and gold Prices which existed earlier may change in future due to change in

energy consumption pattern as the gas is putting a challenge to increasing demand of crude oil.

CHAPTER 4

RESEARCH METHODOLOGY

I have collected data from secondary sources. I have taken crude oil prices from WTI spot and gold prices from London gold prices.

In my research I have used the both qualitative and quantitative approach

Quantitative research is an inquiry into an identified problem' based on testing a theory' measured is with numbers, and analyzed using statistical techniques. The goal of quantitative methods is to determine whether the predictive generalizations of a theory hold true. Quantitative research generates numerical data or data that can be converted into numbers in my research work I have used the WTI crude spot price and London gold prices to know the relationship. My research topic is relationship between Crude and gold. To do same I have used historical prices of both gold and crude.

4.2 TOOLS USED FOR RESEARCH:

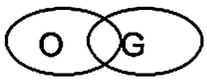
To analyze the Price relationship between crude and gold I have used some Econometrics tool. Which are as under:

i)Correlation

ii) Regression

iii) Causality Analysis (Granger Causalitz)

iv) t-test



i) **Correlation**

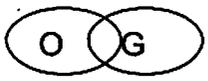
I used Correlation in my research work because this is a statistical technique which can show whether price of crude and gold and how strongly are related .Correctional studies examine the relationships between variables in a Study. Direct relationships (positive correlations) exist when high scores on one variable are associated with high scores on another variable, as when intelligence is positively correlated with grade point average. Inverse relationships (negative correlations) exist when high scores on one variable are associated with /low /scores on a second variable,

ii) **Regression**

In statistics, **regression analysis** examines the relation of a dependent variable (response variable) to specified independent variables (predictors).in my research work gold prices is dependent and crude price is independent variable. The mathematical model of their relationship is the regression equation. The Gold prices is modeled as a random variable because of uncertainty as to its value, given values of the Crude prices. A regression equation contains estimates of one or more unknown regression parameters which quantitatively link the dependent and independent variables. The parameters are estimated from data. Regression analysis depends on certain assumptions

1. The predictors must be linearly independent, i.e it must not possible to express any predictor as a linear combination of the others.

2. The error terms must be normally distributed and independent.



3. The variance of the error terms must be constant.

iii)Causality Analysis (Granger Causalitz)

The procedure for testing statistical causality between stock prices and the economy is the direct "Granger-causality" test proposed by C. J. Granger in 1969. Granger causality may have more to do with precedence, or prediction, than with causation in the usual sense. It suggests that while the past can cause/predict the future, the future cannot cause/predict the past. By using this tool I want to establish the relation between gold and crude prices . by using this tool I want to know that if any relationship exist than in future also this can be predicted that gold and crude oil prices will predict each other.

iv) **T-test**:

The t-test assesses whether the means of two groups are statistically different from each other. This analysis is appropriate whenever you want to compare the means of two groups, and especially appropriate as the analysis for the posttest-only two-group randomized experimental design.

CHAPTER 5

REASONS FOR CORRELATION BETWEEN OIL AND GOLD

The reasons why gold and oil may be co integrated are:

a) The oil revenue is invested heavily in gold, therefore pushing up gold price

b) There is an upward pressure on inflation, which increases the appeal of gold as an inflation hedge.

c) One reason as analyzed by experts is that gold miners are major CONSUMERS of oil (a large chunk of a gold miner's costs are energy-related).

Higher oil prices cause concern over "inflation" which drives demand for gold. rising oil prices will drive up the consumer price index (the mainstream view of inflation) and people will feel that perhaps they should trade in some of their dollars for gold because gold will also rise in price. If you're holding U.S. dollars and they're declining in value against other paper money, then these U.S. dollars are probably declining even faster against the world's oldest money in the form of precious metals.

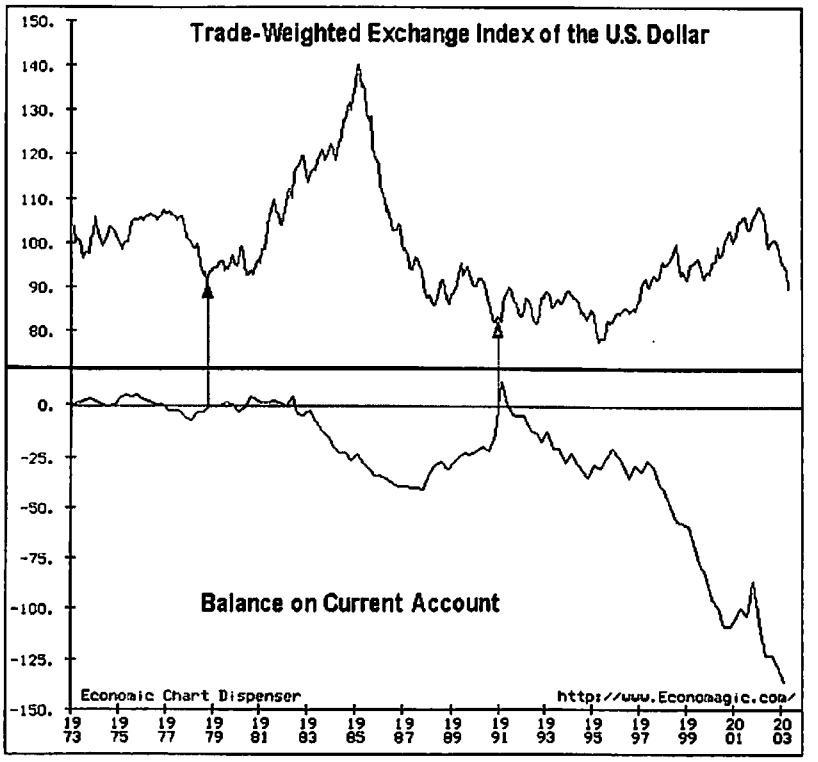
THE DOLLAR

The US$ can rise in the face of a current account deficit for a very long time, so the current account deficit cannot be used to determine when a US$ bear market is going to begin. However, once a US$ bear market is set in motion it tends to continue until the quarterly US current account moves into surplus (refer to the below long-term chart comparing the trade-weighted dollar index with the quarterly balance on current account).

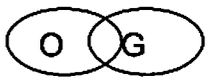
Therefore, if we assume that a US$ bear market is in progress, a reasonable assumption considering the price action and the fact that the dollar remains over-valued based on some important measures, then this bear market has a long way to go before it ends. This is because the current account deficit is still hitting new all-time highs.

As an aside, the below chart shows the current account in billions of dollars. If, however, we look at the current account deficit as a percentage of GDP, this is what we get:

1. The deficit peaked in Q1 1978 at 1.3% of GDP
2. The deficit peaked in Q4 1987 at 3.4% of GDP
3. In Q1 2003 (the latest available data), the deficit was 5.1% of GDP.



Source: www.economic.com



The decline in the US$ that has occurred over the past 18 months has not yet had any noticeable effect on the current account balance. This is not, however, unusual or unexpected. For starters, most of the decline in the dollar from its 1985 peak occurred while the current account deficit was still expanding. Also, a large and growing component of the US current account deficit is the trade deficit with China. The Chinese currency is pegged to the US$ so a weakening US$ does nothing to reduce this trade deficit. All it does is give China a greater competitive advantage over other exporters to the US

TREND

Gold prices rose in New York on speculation higher energy costs will boost the appeal of the precious metal as an inflation hedge. Gold sometimes moves in the same direction as the price of oil, which has almost tripled in the past five years. Gold reached a 26-year high of $732 an ounce in May and oil climbed to a record in July.

The investment demand for the US$, and hence gold, is influenced by inflation expectations, the US current account deficit, the US budget deficit, and the expected future returns on dollar-denominated assets and debt. As at the end of last week the yield spread was 3.76%, having recently moved sharply higher due to the upturn in the bond yield and the on-going efforts by the Fed to keep short-term interest rates at a very low level. As long as the Fed maintains the downward pressure on rates at the short-end, any rise in long-term interest rates will be bullish for gold stocks. At some point, of course,

the Fed will be forced by the market to drive short-term rates up at a faster pace than long-term rates and the trend for gold stocks will no longer be bullish, but we are a long way from that point. As discussed in previous commentaries, long-term interest rates are likely to move much higher over the coming 12 months and the Fed will, as always, be slow to react to the changing circumstances. As such, the yield spread is likely to move considerably higher before a trend reversal occurs.

CHAPTER 6
DATA ANALYSIS AND ITS INTERPRETATION

5.1 DATA ANALYSIS

The logical approach of identifying the main causes of the correlation between crude oil and gold and then finding specific solutions was followed. A thorough study of the trend revealed various causes of correlation between the oil and gold.

In my research I have focused my scope on two aspects, viz:

1. The research limits the analysis of crude oil and gold prices to the period 2000-2006.
2. The study uses only select econometrics tools.
3. Monthly West Texas Index(WTI)Crude and London Gold prices used in this study as data.

Correlation –

	Column 1	*Column 2*
Column 1	1	
Column 2	0.883108	1

There is strong co relation between Gold and Oil Price. And .88 times Gold prices changes when Crude Oil price changes. Gold and Crude Oil are highly correlation with each other. When Crude Oil rises 88% of time gold price also rise.

Regression Analysis –

SUMMARY
OUTPUT

Regression Statistics	
Multiple R	0.882050759
R Square	0.778013542
Adjusted R Square	0.775272968
Standard Error	0.131056939
Observations	83

ANOVA

	Df	*SS*	*MS*	*F*
Regression	1	4.876022855	4.876022855	283.887
Residual	81	1.391249618	0.017175921	
Total	82	6.267272473		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	3.508916917	0.142986791	24.5401474	2.9310
3.305420426	0.663167514	0.039359575	16.8489502	3.3543

R2 = .77

F=283

I) The positive sign of co efficient of crude oil shows that on an average, gold and crude oil prices are positively related. When Crude prices rises by 1% on an average, gold prices also rises by .66% .this coefficient is statistically highly significant at 1% level.

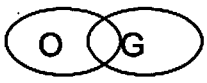
II) The overall fit of the model on indicated by R2 is quite good , the crude explains 77% of variation in the gold prices.

E.g.

Gold =3.5+.66Crude

T =24.54 16.84

Se =.14 .03



Causality in Econometrics:

The Granger Causality test

The null hypothesis is $b_i = 0$ for all values of i.

The alternative hypothesis is bi # 0 for all value of i

Gold prices =α+β1 gold t-1+ β2 gold t-2+eroor terms

If the F-value exceeds the critical F-value at the chosen level of significance, the null hypothesis is rejected, in which case the lagged S&P 500 variable belongs in the regression. This would imply that stock prices "Granger cause" or improve the prediction of the economy. We then use the same steps for equation 2 to test whether the economy Although regression analysis deals with the dependence of one variables on other.

Gold prices =α+ β1 gold t-1+ β2 gold t-2+ β1 crude oil price t-1+ β2 crude oil price t-2+et

It does not necessarily imply causation or direction of influence, but in regressions involving time series data the situation may be same.

The results of first test is

F =(.2375 /3)/.(2302/81-2*5-1)

=.44

And the critical f is 2.37

So we will reject the null of β3= β4=0

Can not be reflected in the calculated F: less than critical F So we can say that crude prices do not Ganger cause Gold prices.

T-test:

Null hypothesis: Po = o

There is no co relationship between crude and gold prices.

Alternative hypothesis : P1 = there is co relationship between crude oil and gold prices

Calculated t	critical
25.73	1.97

The calculated t value is grater than critical (tabulated) value at 5%level of confidence.

So We reject the null hypothesis.

No correlation ship between gold prices and crude oil prices.

This implies that the gold prices and crude oil prices are correlated.

t-Test: Two-Sample Assuming Equal Variances

	5.6501	*3.30542*
Mean	5.905871	3.614402
Variance	0.07643	0.135209
Observatio	83	83
Pooled Var	0.10582	
Hypothesiz	0	
df	164	
t Stat	45.37902	
P(T<=t) on	4.71E-95	
t Critical or	1.654198	
P(T<=t) tw	9.43E-95	
t Critical tw	1.974535	

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.980735319
R Square	0.961841767
Adjusted R Squar	0.960875735
Standard Error	0.054837798
Observations	82

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	2	5.988285	2.994143	995.6632	9.39E-57
Residual	79	0.237568	0.003007		
Total	81	6.225853			

	Coefficients	*tandard Erı*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*
Intercept	-0.025436635	0.135039	-0.188365	0.851074	-0.294226	0.243352	-0.294226
X Variable 1	0.881431627	0.11122	7.925116	1.22E-11	0.660054	1.10281	0.660054
X Variable 2	0.124617728	0.113528	1.097682	0.275678	-0.101354	0.35059	-0.101354

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.980352247
R Square	0.961090528
Adjusted R Squar	0.959069257
Standard Error	0.074662015
Observations	82

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	10.60227586	2.650568965	475.4881	1.98124E-53
Residual	77	0.42923007	0.005574416		
Total	81	11.03150593			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	-0.603243882	0.254174039	-2.373349708	0.020122	-1.109369047
X Variable 1	-0.180816238	0.154411184	-1.171004801	0.245208	-0.488288181
X Variable 2	0.366899774	0.157511352	2.329354488	0.022464	0.053254608
X Variable 3	1.007304698	0.108746132	9.262901355	3.74E-14	0.790763487
X Variable 4	-0.141223736	0.109527981	-1.289385001	0.201124	-0.359321807

Upper 95%	*ower 95.0%*	*Upper 95.0%*
-0.097119	-1.109369	-0.097119
0.126656	-0.488288	0.126656
0.680545	0.053255	0.680545
1.223846	0.790763	1.223846
0.076874	-0.359322	0.076874

CHAPTER 7:

FINDINGS & SUGGESTIONS

FINDINGS OF THE STUDY:

i) Crude prices do have a strong correlation with gold since oil prices

ii) When crude price rises by 1% on an average gold price also rise by 0.66%.

iii) The crude explains 77% of variation in gold prices.

iv)The causality test indicates that the crude oil price defines and drives the gold prices. Our results indicated a "causal" relationship between the oil and gold. We found that no reverse causality was observed.

SUGGESTIONS:

1. One should not invest in both oil and gold (stocks) together as both the commodities are positively correlated.

2. Few analysts have suggested that the payment for oil can also be done through gold. But. if oil producers begin to sell the trillions they hold with the help of precious metals, the cost of the commodity will rise to levels that today are hard to imagine. Hence, the payment should not be done through gold.

CHAPTER 8

CONCLUSION

CONCLUSION

The purpose of this paper was to evaluate the correlation ship between crude oil and gold. The research work has come up with the following conclusions:

1. Oil prices do have a strong correlation with gold since oil prices do have a tremendous impact on the world economy and so on financial markets.

2. Rising oil prices will drive up the consumer price index (the mainstream view of inflation) and people feel that perhaps they should trade in some of their dollars for gold because gold will also rise in price. Hence oil and gold are directly related to each other.

3. The positive sign of coefficient of crude oil shows that on an average gold and crude oil prices are positively related. When crude price rises by 1% on an average gold price also rise by 0.66%. This coefficient is statically highly significant at 1% level.

4. The price of oil is poised to rise steadily as the supply/demand imbalance increases and the dollar declines, even if there are no supply disruptions, terrorist threats or geopolitical impacts are a concern. As this happens, the price of precious metals will climb until they eventually catch up.

4. The overall fit of the model on indicated by R^2 is quite good.

5. The causality test indicates that the crude oil price defines and drives the gold prices. Our results indicated a "causal" relationship between the oil and gold. We found that no reverse causality was observed.

6. The crude explains 77% of variation in gold prices. (T-test)

7. Gold can be used as a hedging instrument to control inflation.

SUGGESTIONS

1. One should not invest in both oil and gold (stocks) together as both the commodities are positively correlated.

2. Few analysts have suggested that the payment for oil can also be done through gold. But, if oil producers begin to sell the trillions they hold with the help of precious metals, the cost of the commodity will rise to levels that today are hard to imagine. Hence, the payment should not be done through gold.

BIBLIOGRAPHY

Bibliography

1. Adelman, M. A., 1995, *World oil since 1970* Cambridge, Mass. and London: MIT ress

2. Friedman, Milton, "The Role of Monetary Policy", *American Economic Review* 1968

3. Lucas, Robert E., Jr., "Adjustment Costs and the Theory of Supply", *Journal of Political Economy*, 1967

4. Agbeyegbe, Terence D., "Interest Rates and Metal Price Movements: Further Evidence," *Journal of Environment and Economic Management*, 1989

5. Hotelling , H. "The Economics of Exhaustible Resources " *Journal of Political.* (1931)

6. Frankel, Jeffrey A. "Expectations and Commodity Price Dynamics: The Overshooting Model." *American Journal of Agricultural Economics* 1986

7. Gillman, Max, and Michal Kejak , "Modeling the Inflation- Growth Effect", Central European University Economics Working Paper 2000,

8. Hooker, Mark A., 1999. "Oil and the Macro economy Revisited", Federal Reserve Board working paper

9. Barsky, Robert and Lutz Kilian, *Center for Economic Policy Research* Discussion,2000

10. Engle, Robert F. and C.W.J. Granger. "Co-integration and Error Correction Representation, Estimation , and Testing," *Econometric* 55. 1987

11. Granger, C. W. .J. "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods," Econometric Movements," *Review of Economic Studies*. 1969.

12. Johansen, Soren "Estimation and Hypothesis Testing of Co integration Vectors in Gaussian Vector Autoregressive Models," *Econometrica*, 1991

13 "Relationship between oil and gold", Max Gillman and Anton Nakov Bailey, publication - Westernlore Press, Los Angeles, p. 89-93

1. Gold and Oil : California market, Phillip B, vol 2, p.27-33,San Fransisco, july 1997
2. Discoverer of gold: Soc. California Pioneers Quarterly, vol. 1, no. 3, p. 3-43, San Francisco. September 1924.
3. Gold and Oil Ratio, Richard Bentley, London publication, 244 p.
4. Cendrars, Blaise, 1926, Sutters gold: Harper and Bros., New York and London, Translated from French by Henry L. Stuart, 179 p.
5. Paul. Rodman W., 1947, California gold: Harvard Univ. Press, Cambridge, Mass., 380 p.
6. Gillman, Max, and Michal Kejak, "Modeling the Inflation- Growth Effect", Central European University Economics Working Paper, 2000
7. Hooker, Mark A., "Oil and the Macro economy Revisited", Federal Reserve Board working paper1999.
8. Barsky, Robert and Lutz Kilian, *Center for Economic Policy Research* Discussion 2000

Websites:

1. www.infraline.com

2. www.worldgoldcouncil.com

3. www.kitos.com

4. www.eim.com

APPENDIX

co - relation between crude oil and gold

year	Months	gold prices	crude oil prices	gold prices (log)	gold prices (log)
2000	January	284.32	27.26	5.650100364	
	February	299.94	29.37	5.703582455	
	March	286.39	29.84	5.657354518	5.703582455
	April	279.86	25.72	5.634289478	5.657354518
	May	275.31	28.79	5.617897735	5.634289478
	June	285.73	31.82	5.655047309	5.617897735
	July	281.55	29.7	5.640310052	5.655047309
	August	274.47	31.29	5.614841965	5.640310052
	September	273.68	33.88	5.611959541	5.614841965
	October	270	33.11	5.598421959	5.611959541
	November	266.01	34.42	5.583533902	5.598421959
	December	271.45	28.44	5.60377796	5.583533902
2001	January	265.49	29.59	5.581577175	5.60377796
	February	261.86	29.61	5.56781001	5.581577175
	March	263.03	27.24	5.572268094	5.56781001
	April	260.48	27.49	5.562526083	5.572268094
	May	272.35	28.63	5.607088004	5.562526083
	June	270.23	27.6	5.599273448	5.607088004
	July	267.53	26.42	5.58923171	5.599273448
	August	272.39	27.37	5.607234863	5.58923171
	September	283.42	26.2	5.646929896	5.607234863
	October	283.06	22.17	5.645658889	5.646929896
	November	276.16	19.64	5.620980408	5.645658889
	December	275.85	19.39	5.61985724	5.620980408
2002	January	281.65	19.71	5.640665165	5.61985724
	February	295.5	20.72	5.688668837	5.640665165
	March	294.05	24.53	5.683749821	5.688668837
	April	302.68	26.18	5.712676142	5.683749821
	May	314.49	27.04	5.750952279	5.712676142
	June	321.18	25.52	5.772001714	5.750952279
	July	313.29	26.97	5.747129279	5.772001714
	August	310.25	28.39	5.737378424	5.747129279
	September	319.16	29.66	5.765692544	5.737378424
	October	316.56	28.84	5.757512797	5.765692544
	November	319.15	26.35	5.765661212	5.757512797
	December	332.43	29.46	5.806429312	5.765661212
2003	January	256.86	32.95	5.548531189	5.806429312
	February	258.97	35.83	5.556712225	5.548531189
	March	340.55	33.51	5.830561958	5.556712225
	April	328.18	28.17	5.793562238	5.830561958
	May	355.53	28.11	5.873609634	5.793562238
	June	356.53	30.66	5.876418388	5.873609634
	July	351.02	30.75	5.860843202	5.876418388
	August	359.77	31.57	5.885464938	5.860843202
	September	378.95	28.31	5.93740427	5.885464938
	October	378.92	30.34	5.937325101	5.93740427
	November	389.91	31.11	5.965915943	5.937325101
	December	407.59	32.13	6.010261767	5.965915943
2004	January	413.99	34.31	6.025841819	6.010261767
	February	405.33	34.68	6.00470155	6.025841819

gold prices (log)			crude oil prices (log)
			3.305420426
			3.379973745
5.650100364	3.379973745	3.305420426	3.395849775
5.703582455	3.395849775	3.379973745	3.247268899
5.657354518	3.247268899	3.395849775	3.360028105
5.634289478	3.360028105	3.247268899	3.460095023
5.617897735	3.460095023	3.360028105	3.391147046
5.655047309	3.391147046	3.460095023	3.443298558
5.640310052	3.443298558	3.391147046	3.52282487
5.614841965	3.52282487	3.443298558	3.499835352
5.611959541	3.499835352	3.52282487	3.538637791
5.598421959	3.538637791	3.499835352	3.347796605
5.583533902	3.347796605	3.538637791	3.387436466
5.60377796	3.387436466	3.347796605	3.388112142
5.581577175	3.388112142	3.387436466	3.304686481
5.56781001	3.304686481	3.388112142	3.313822302
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5.646929896	3.098740024	3.265759411	2.977568303
5.645658889	2.977568303	3.098740024	2.964757469
5.620980408	2.964757469	2.977568303	2.981126121
5.61985724	2.981126121	2.964757469	3.031099417
5.640665165	3.031099417	2.981126121	3.199896858
5.688668837	3.199896858	3.031099417	3.26499576
5.683749821	3.26499576	3.199896858	3.297317251
5.712676142	3.297317251	3.26499576	3.239462458
5.750952279	3.239462458	3.297317251	3.294725137
5.772001714	3.294725137	3.239462458	3.34603697
5.747129279	3.34603697	3.294725137	3.389799337
5.737378424	3.389799337	3.34603697	3.361763312
5.765692544	3.361763312	3.389799337	3.271468275
5.757512797	3.271468275	3.361763312	3.383033411
5.765661212	3.383033411	3.271468275	3.494991261
5.806429312	3.494991261	3.383033411	3.578785531
5.548531189	3.578785531	3.494991261	3.511843902
5.556712225	3.511843902	3.578785531	3.338257582
5.830561958	3.338257582	3.511843902	3.336125385
5.793562238	3.336125385	3.338257582	3.422958873
5.873609634	3.422958873	3.336125385	3.425889994
5.876418388	3.425889994	3.422958873	3.452207303
5.860843202	3.452207303	3.425889994	3.343215099
5.885464938	3.343215099	3.452207303	3.412466974
5.93740427	3.412466974	3.343215099	3.437529311
5.937325101	3.437529311	3.412466974	3.469790173
5.965915943	3.469790173	3.437529311	3.535436857
6.010261767	3.535436857	3.469790173	3.546163152

	March	406.67	36.74	6.008002046	6.00470155
	April	403.02	36.75	5.998986189	6.008002046
	May	383.45	40.28	5.949209234	5.998986189
	June	391.99	38.03	5.971236329	5.949209234
	July	398.09	40.78	5.98667811	5.971236329
	August	400.48	44.9	5.992663828	5.98667811
	September	405.27	45.94	6.004553512	5.992663828
	October	420.46	53.28	6.04134935	6.004553512
	November	439.39	48.47	6.085387401	6.04134935
	December	441.76	43.15	6.090766748	6.085387401
2005	January	424.15	46.84	6.050087166	6.090766748
	February	423.35	48.15	6.04819926	6.050087166
	March	434.24	54.19	6.073597377	6.04819926
	April	428.93	52.98	6.061293735	6.073597377
	May	421.87	49.83	6.04469721	6.061293735
	June	430.66	56.35	6.065318916	6.04469721
	July	424.48	59	6.05086489	6.065318916
	August	437.93	64.99	6.08205908	6.05086489
	September	456.04	65.59	6.122580525	6.08205908
	October	469.9	62.26	6.152519906	6.122580525
	November	476.67	58.32	6.166824428	6.152519906
	December	509.76	59.41	6.233940027	6.166824428
2006	January	549.86	65.49	6.3096637	6.233940027
	February	555	61.63	6.318968114	6.3096637
	March	557.09	62.69	6.322726807	6.318968114
	April	610.65	69.44	6.414523964	6.322726807
	May	676.51	70.84	6.516947229	6.414523964
	June	596.15	70.95	6.390492313	6.516947229
	July	633.77	74.41	6.451686113	6.390492313
	August	632.59	73.04	6.449822503	6.451686113
	September	598.19	63.8	6.393908429	6.449822503
	October	585.78	58.89	6.372944292	6.393908429
	November	627.83	59.08	6.442269429	6.372944292
	December	629.79	61.96	6.44538643	6.442269429

0.906243644

6.025841819	3.546163152	3.535436857	3.60386608	
6.00470155	3.60386608	3.546163152	3.604138226	
6.008002046	3.604138226	3.60386608	3.695855068	
5.998986189	3.695855068	3.604138226	3.638375322	
5.949209234	3.638375322	3.695855068	3.708191765	
5.971236329	3.708191765	3.638375322	3.804437795	
5.98667811	3.804437795	3.708191765	3.827336197	
5.992663828	3.827336197	3.804437795	3.975561026	#REF!
6.004553512	3.975561026	3.827336197	3.88094505	
6.04134935	3.88094505	3.975561026	3.764682418	
6.085387401	3.764682418	3.88094505	3.846737539	
6.090766748	3.846737539	3.764682418	3.874321138	
6.050087166	3.874321138	3.846737539	3.99249639	
6.04819926	3.99249639	3.874321138	3.969914484	
6.073597377	3.969914484	3.99249639	3.908617212	
6.061293735	3.908617212	3.969914484	4.03158224	
6.04469721	4.03158224	3.908617212	4.077537444	
6.065318916	4.077537444	4.03158224	4.174233412	
6.05086489	4.174233412	4.077537444	4.183423245	
6.08205908	4.183423245	4.174233412	4.131319165	
6.122580525	4.131319165	4.183423245	4.065945088	
6.152519906	4.065945088	4.131319165	4.084462562	
6.166824428	4.084462562	4.065945088	4.181897459	
6.233940027	4.181897459	4.084462562	4.121148765	
6.3096637	4.121148765	4.181897459	4.138201945	
6.318968114	4.138201945	4.121148765	4.24046307	
6.322726807	4.24046307	4.138201945	4.260423813	
6.414523964	4.260423813	4.24046307	4.261975404	
6.516947229	4.261975404	4.260423813	4.309590341	
6.390492313	4.309590341	4.261975404	4.291007236	
6.451686113	4.291007236	4.309590341	4.15575319	
6.449822503	4.15575319	4.291007236	4.075671297	
6.393908429	4.075671297	4.15575319	4.078892458	
6.372944292	4.078892458	4.075671297	4.126489016	

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.981335912
R Square	0.963020173
Adjusted R Square	0.961099143
Standard Error	0.054681007
Observations	82

ANOVA

	df	*SS*
Regression	4	5.995621892
Residual	77	0.230230962
Total	81	6.225852853

	Coefficients	*Standard Error*
Intercept	0.167662923	0.186152119
X Variable 1	0.84887049	0.113087746
X Variable 2	0.090860129	0.115358248
X Variable 3	0.062586316	0.079643551
X Variable 4	-0.007784254	0.080216162

MS	F	Significance F
1.498905473	501.3040846	2.8E-54
0.002990012		

t Stat	P-value	Lower 95%	Upper 95%	ower 95.0%	Upper 95.0%
0.90067695	0.370568538	-0.203013	0.538339	-0.203013	0.538339
7.506299513	9.02554E-11	0.623684	1.074057	0.623684	1.074057
0.787634442	0.433328456	-0.138847	0.320568	-0.138847	0.320568
0.785830308	0.434378469	-0.096004	0.221177	-0.096004	0.221177
-0.097040966	0.922946006	-0.167515	0.151947	-0.167515	0.151947

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.882050759
R Square	0.778013542
Adjusted R Square	0.775272968
Standard Error	0.131056939
Observations	83

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4.876022855	4.876022855	283.8871229	3.35433E-28
Residual	81	1.391249618	0.017175921		
Total	82	6.267272473			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	3.508916917	0.142986791	24.5401474	2.93109E-39	3.22441806
3.305420426	0.663167514	0.039359575	16.8489502	3.35433E-28	0.584854308

interpretation----> 66 times golds prices changes when crude oil prices change

Upper 95%	*Lower 95.0%*	*Upper 95.0%*
3.793415774	3.22441806	3.793415774
0.74148072	0.584854308	0.74148072

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.977697
R Square	0.955892
Adjusted R	0.954775
Standard E	0.078481
Observatio	82

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	2	10.54492	5.272461	856.0192	2.87E-54
Residual	79	0.486583	0.006159		
Total	81	11.03151			

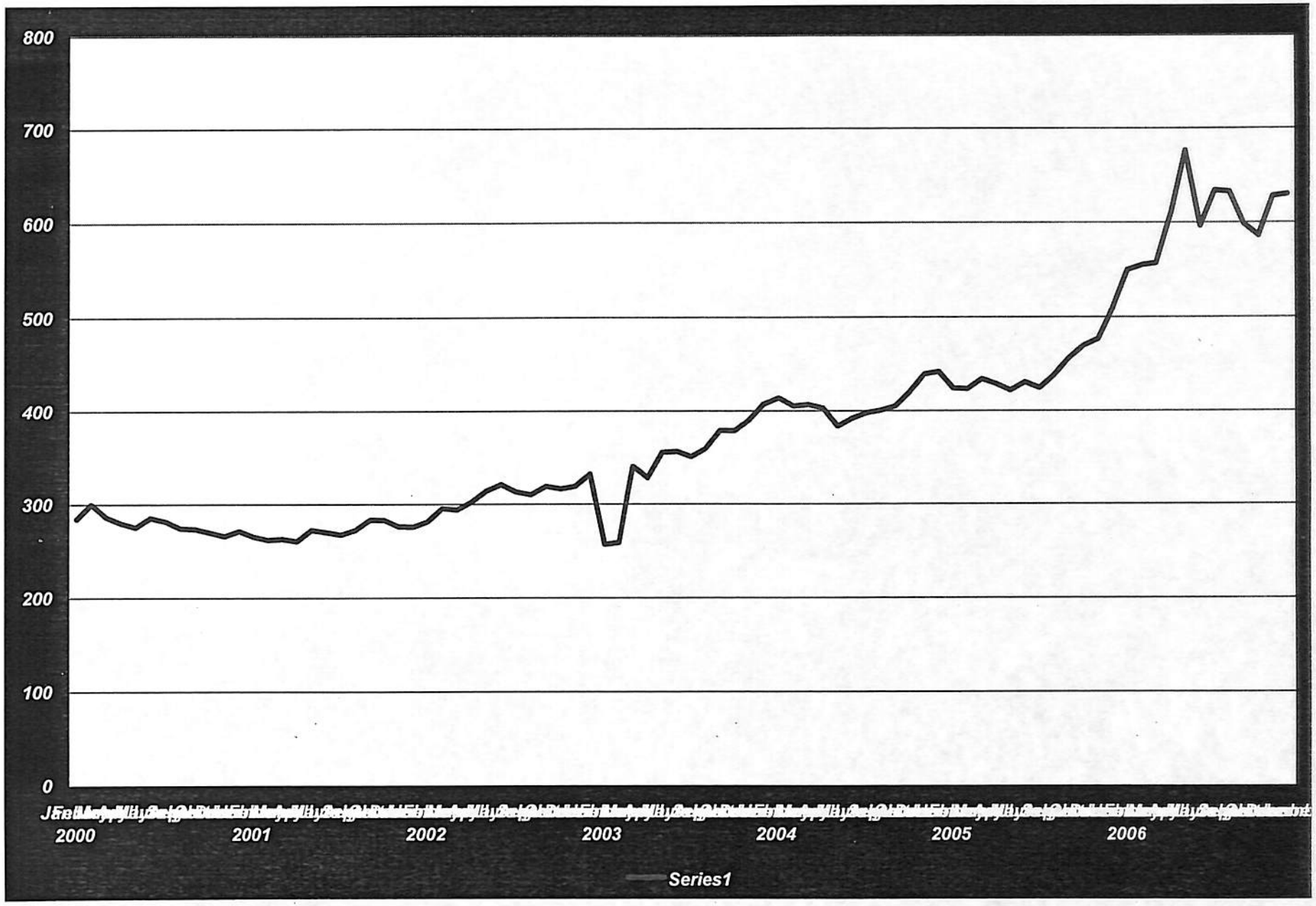
	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	0.064103	0.087187	0.735233	0.464375	-0.109439	0.237644	-0.109439	0.237644
X Variable	1.067852	0.111934	9.540027	8.61E-15	0.845054	1.290651	0.845054	1.290651
X Variable	-0.083313	0.11265	-0.739572	0.461752	-0.307538	0.140912	-0.307538	0.140912

Ipper 95.0%
0.243352
1.10281
0.35059

GOLD PRICE MONTHLY (OUNCE /$)

Years	Months	Prices
2000	January	284.32
	February	299.94
	March	286.39
	April	279.86
	May	275.31
	June	285.73
	July	281.55
	August	274.47
	September	273.68
	October	270
	November	266.01
	December	271.45
2001	January	265.49
	February	261.86
	March	263.03
	April	260.48
	May	272.35
	June	270.23
	July	267.53
	August	272.39
	September	283.42
	October	283.06
	November	276.16
	December	275.85
2002	January	281.65
	February	295.5
	March	294.05
	April	302.68
	May	314.49
	June	321.18
	July	313.29
	August	310.25
	September	319.16
	October	316.56
	November	319.15
	December	332.43
2003	January	256.86
	February	258.97
	March	340.55
	April	328.18
	May	355.53
	June	356.53
	July	351.02
	August	359.77
	September	378.95
	October	378.92
	November	389.91
	December	407.59
2004	January	413.99
	February	405.33

	March	406.67
	April	403.02
	May	383.45
	June	391.99
	July	398.09
	August	400.48
	September	405.27
	October	420.46
	November	439.39
	December	441.76
2005	January	424.15
	February	423.35
	March	434.24
	April	428.93
	May	421.87
	June	430.66
	July	424.48
	August	437.93
	September	456.04
	October	469.9
	November	476.67
	December	509.76
2006	January	549.86
	February	555
	March	557.09
	April	610.65
	May	676.51
	June	596.15
	July	633.77
	August	632.59
	September	598.19
	October	585.78
	November	627.83
	December	629.79


800
700
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400
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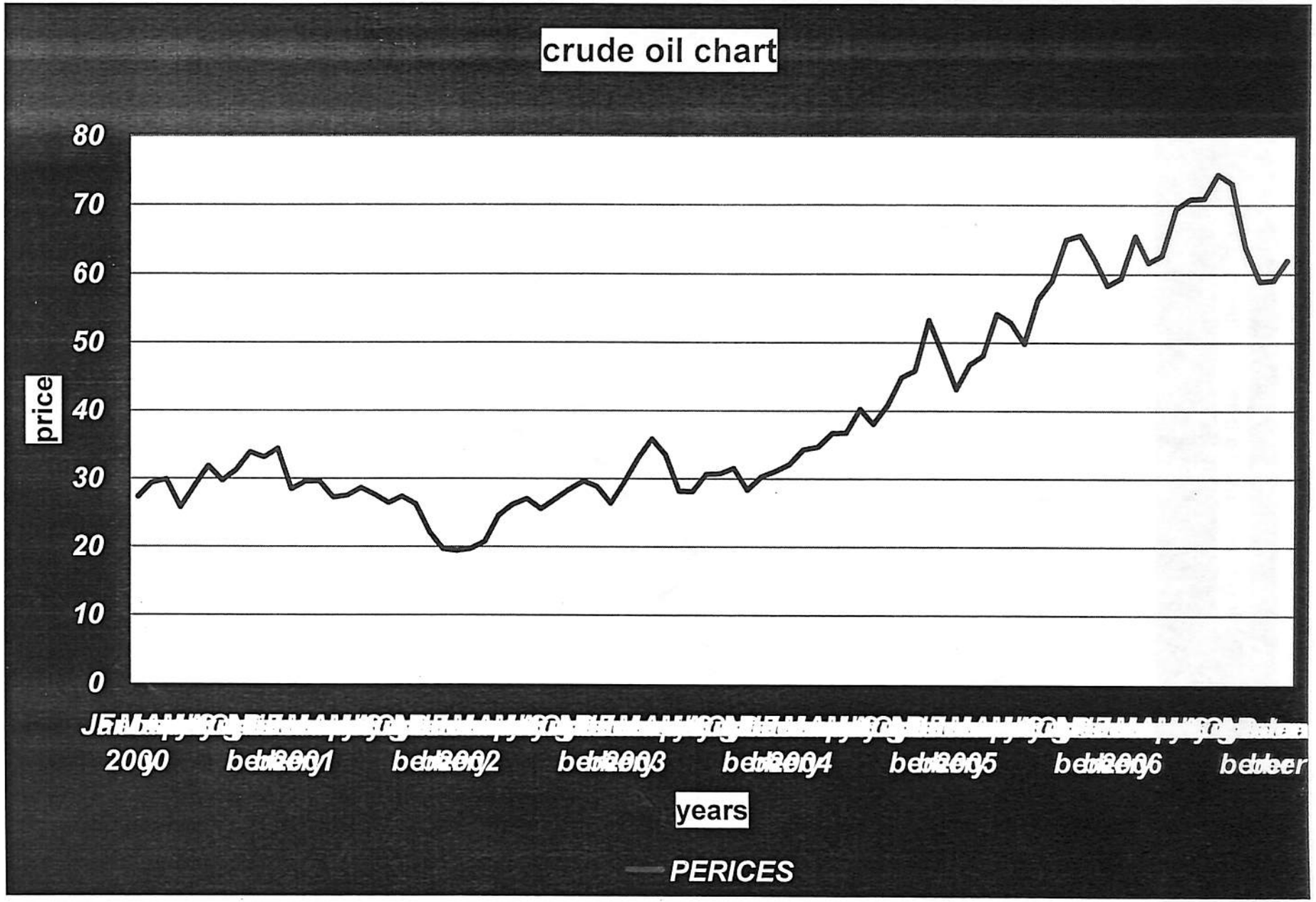
200
100
0
2000
2001
2002
2003
2004
2005
2006
Series1

crude oil prices and charts monthly (WTI BBL/$)

year	months	PERICES	log values
2000	January	27.26	1.435526
	February	29.37	1.467904
	March	29.84	1.474799
	April	25.72	1.410271
	May	28.79	1.459242
	June	31.82	1.5027
	July	29.7	1.472756
	August	31.26	1.494989
	September	33.88	1.529943
	October	33.11	1.519959
	November	34.42	1.536811
	December	28.44	1.45393
2001	January	29.59	1.471145
	February	29.61	1.471438
	March	27.24	1.435207
	April	27.49	1.439175
	May	28.63	1.456821
	June	27.6	1.440909
	July	26.42	1.421933
	August	27.37	1.437275
	September	26.2	1.418301
	October	22.17	1.345766
	November	19.64	1.293141
	December	19.39	1.287578
2002	January	19.71	1.294687
	February	20.72	1.31639
	March	24.53	1.389698
	April	26.18	1.41797
	May	27.04	1.432007
	June	25.52	1.406881
	July	26.97	1.430881
	August	28.39	1.453165
	September	29.66	1.472171
	October	28.84	1.459995
	November	26.35	1.420781
	December	29.46	1.469233
2003	January	32.95	1.517855
	February	35.83	1.554247
	March	33.51	1.525174
	April	28.17	1.449787
	May	28.11	1.448861
	June	30.66	1.486572
	July	30.75	1.487845
	August	31.57	1.499275
	September	28.31	1.45194
	October	30.34	1.482016
	November	31.11	1.4929
	December	32.13	1.506911
2004	January	34.31	1.535421
	February	34.68	1.540079

	March	36.74	1.565139
	April	36.75	1.565257
	May	40.28	1.605089
	June	38.03	1.580126
	July	40.78	1.610447
	August	44.9	1.652246
	September	45.94	1.662191
	October	53.28	1.726564
	November	48.47	1.685473
	December	43.15	1.634981
2005	January	46.84	1.670617
	February	48.15	1.682596
	March	54.19	1.733919
	April	52.98	1.724112
	May	49.83	1.697491
	June	56.35	1.750894
	July	59	1.770852
	August	64.99	1.812847
	September	65.59	1.816838
	October	62.26	1.794209
	November	58.32	1.765818
	December	59.41	1.77386
2006	January	65.49	1.816175
	February	61.63	1.789792
	March	62.69	1.797198
	April	69.44	1.84161
	May	70.84	1.850279
	June	70.95	1.850952
	July	74.41	1.871631
	August	73.04	1.863561
	September	63.8	1.804821
	October	58.89	1.770042
	November	59.08	1.77144
	December	61.96	1.792111


crude oil chart
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50
40
30
20
10
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price
2000
2001
2002
2003
2004
2005
2006
years
PERICES

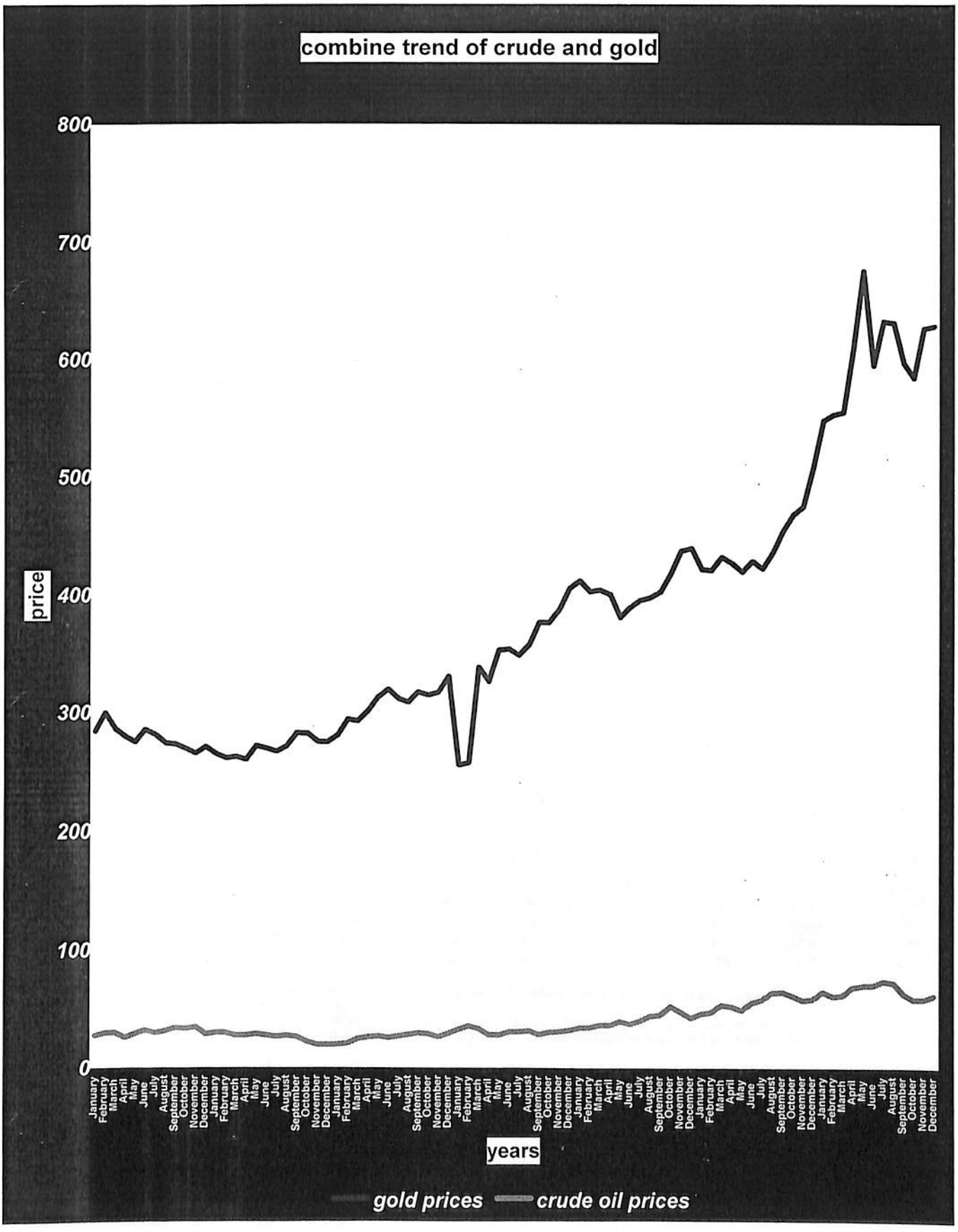

combine trend of crude and gold
800
700
600
500
400
300
200
100
0
price
January
February
March
April
May
June
July
August
September
October
November
December
years
gold prices
crude oil prices

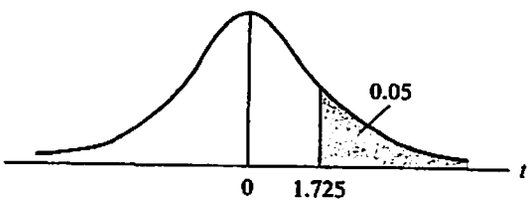
TABLE D.2 PERCENTAGE POINTS OF THE t DISTRIBUTION

Example

$\Pr(t > 2.086) = 0.025$

$\Pr(t > 1.725) = 0.05$ for df = 20

$\Pr(|t| > 1.725) = 0.10$



df \ Pr	0.25 0.50	0.10 0.20	0.05 0.10	0.025 0.05	0.01 0.02	0.005 0.010	0.001 0.002
1	1.000	3.078	6.314	12.706	31.821	63.657	318.31
2	0.816	1.886	2.920	4.303	6.965	9.925	22.327
3	0.765	1.638	2.353	3.182	4.541	5.841	10.214
4	0.741	1.533	2.132	2.776	3.747	4.604	7.173
5	0.727	1.476	2.015	2.571	3.365	4.032	5.893
6	0.718	1.440	1.943	2.447	3.143	3.707	5.208
7	0.711	1.415	1.895	2.365	2.998	3.499	4.785
8	0.706	1.397	1.860	2.306	2.896	3.355	4.501
9	0.703	1.383	1.833	2.262	2.821	3.250	4.297
10	0.700	1.372	1.812	2.228	2.764	3.169	4.144
11	0.697	1.363	1.796	2.201	2.718	3.106	4.025
12	0.695	1.356	1.782	2.179	2.681	3.055	3.930
13	0.694	1.350	1.771	2.160	2.650	3.012	3.852
14	0.692	1.345	1.761	2.145	2.624	2.977	3.787
15	0.691	1.341	1.753	2.131	2.602	2.947	3.733
16	0.690	1.337	1.746	2.120	2.583	2.921	3.686
17	0.689	1.333	1.740	2.110	2.567	2.898	3.646
18	0.688	1.330	1.734	2.101	2.552	2.878	3.610
19	0.688	1.328	1.729	2.093	2.539	2.861	3.579
20	0.687	1.325	1.725	2.086	2.528	2.845	3.552
21	0.686	1.323	1.721	2.080	2.518	2.831	3.527
22	0.686	1.321	1.717	2.074	2.508	2.819	3.505
23	0.685	1.319	1.714	2.069	2.500	2.807	3.485
24	0.685	1.318	1.711	2.064	2.492	2.797	3.467
25	0.684	1.316	1.708	2.060	2.485	2.787	3.450
26	0.684	1.315	1.706	2.056	2.479	2.779	3.435
27	0.684	1.314	1.703	2.052	2.473	2.771	3.421
28	0.683	1.313	1.701	2.048	2.467	2.763	3.408
29	0.683	1.311	1.699	2.045	2.462	2.756	3.396
30	0.683	1.310	1.697	2.042	2.457	2.750	3.385
40	0.681	1.303	1.684	2.021	2.423	2.704	3.307
60	0.679	1.296	1.671	2.000	2.390	2.660	3.232
120	0.677	1.289	1.658	1.980	2.358	2.617	3.160
∞	0.674	1.282	1.645	1.960	2.326	2.576	3.090

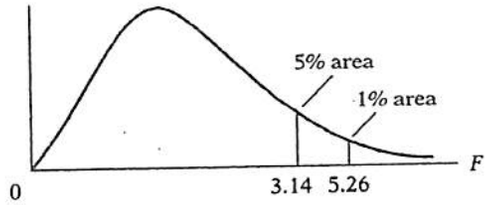
Note: The smaller probability shown at the head of each column is the area in one tail; the larger probability is the area in both tails.

Source: From E. S. Pearson and H. O. Hartley, eds., *Biometrika Tables for Statisticians*, vol. 1, 3d ed., table 12, Cambridge University Press, New York, 1966. Reproduced by permission of the editors and trustees of *Biometrika*.

TABLE D.3 UPPER PERCENTAGE POINTS OF THE F DISTRIBUTION

Example

$\Pr(F > 1.59) = 0.25$
$\Pr(F > 2.42) = 0.10$ for df $N_1 = 10$
$\Pr(F > 3.14) = 0.05$ and $N_2 = 9$
$\Pr(F > 5.26) = 0.01$



df for denominator N_2	Pr	df for numerator N_1: 1	2	3	4	5	6	7	8	9	10	11	12
1	.25	5.83	7.50	8.20	8.58	8.82	8.98	9.10	9.19	9.26	9.32	9.36	9.41
	.10	39.9	49.5	53.6	55.8	57.2	58.2	58.9	59.4	59.9	60.2	60.5	60.7
	.05	161	200	216	225	230	234	237	239	241	242	243	244
2	.25	2.57	3.00	3.15	3.23	3.28	3.31	3.34	3.35	3.37	3.38	3.39	3.39
	.10	8.53	9.00	9.16	9.24	9.29	9.33	9.35	9.37	9.38	9.39	9.40	9.41
	.05	18.5	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4
	.01	98.5	99.0	99.2	99.2	99.3	99.3	99.4	99.4	99.4	99.4	99.4	99.4
3	.25	2.02	2.28	2.36	2.39	2.41	2.42	2.43	2.44	2.44	2.44	2.45	2.45
	.10	5.54	5.46	5.39	5.34	5.31	5.28	5.27	5.25	5.24	5.23	5.22	5.22
	.05	10.1	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.76	8.74
	.01	34.1	30.8	29.5	28.7	28.2	27.9	27.7	27.5	27.3	27.2	27.1	27.1
4	.25	1.81	2.00	2.05	2.06	2.07	2.08	2.08	2.08	2.08	2.08	2.08	2.08
	.10	4.54	4.32	4.19	4.11	4.05	4.01	3.98	3.95	3.94	3.92	3.91	3.90
	.05	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.94	5.91
	.01	21.2	18.0	16.7	16.0	15.5	15.2	15.0	14.8	14.7	14.5	14.4	14.4
5	.25	1.69	1.85	1.88	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89
	.10	4.06	3.78	3.62	3.52	3.45	3.40	3.37	3.34	3.32	3.30	3.28	3.27
	.05	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.71	4.68
	.01	16.3	13.3	12.1	11.4	11.0	10.7	10.5	10.3	10.2	10.1	9.96	9.89
6	.25	1.62	1.76	1.78	1.79	1.79	1.78	1.78	1.78	1.77	1.77	1.77	1.77
	.10	3.78	3.46	3.29	3.18	3.11	3.05	3.01	2.98	2.96	2.94	2.92	2.90
	.05	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.03	4.00
	.01	13.7	10.9	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.79	7.72
7	.25	1.57	1.70	1.72	1.72	1.71	1.71	1.70	1.70	1.69	1.69	1.69	1.68
	.10	3.59	3.26	3.07	2.96	2.88	2.83	2.78	2.75	2.72	2.70	2.68	2.67
	.05	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.60	3.57
	.01	12.2	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.54	6.47
8	.25	1.54	1.66	1.67	1.66	1.66	1.65	1.64	1.64	1.63	1.63	1.63	1.62
	.10	3.46	3.11	2.92	2.81	2.73	2.67	2.62	2.59	2.56	2.54	2.52	2.50
	.05	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.31	3.28
	.01	11.3	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.73	5.67
9	.25	1.51	1.62	1.63	1.63	1.62	1.61	1.60	1.60	1.59	1.59	1.58	1.58
	.10	3.36	3.01	2.81	2.69	2.61	2.55	2.51	2.47	2.44	2.42	2.40	2.38
	.05	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.10	3.07
	.01	10.6	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.18	5.11

Source: From E. S. Pearson and H. O. Hartley, eds., *Biometrika Tables for Statisticians*, vol. 1, 3d ed., table 18, Cambridge University Press, New York, 1966. Reproduced by permission of the editors and trustees of *Biometrika*.

df for numerator N_1													df for denominator N_2
15	20	24	30	40	50	60	100	120	200	500	∞	Pr	
9.49	9.58	9.63	9.67	9.71	9.74	9.76	9.78	9.80	9.82	9.84	9.85	.25	
61.2	61.7	62.0	62.3	62.5	62.7	62.8	63.0	63.1	63.2	63.3	63.3	.10	1
246	248	249	250	251	252	252	253	253	254	254	254	.05	
3.41	3.43	3.43	3.44	3.45	3.45	3.46	3.47	3.47	3.48	3.48	3.48	.25	
9.42	9.44	9.45	9.46	9.47	9.47	9.47	9.48	9.48	9.49	9.49	9.49	.10	2
19.4	19.4	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	.05	
99.4	99.4	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	.01	
2.46	2.46	2.46	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	.25	
5.20	5.18	5.18	5.17	5.16	5.15	5.15	5.14	5.14	5.14	5.14	5.13	.10	3
8.70	8.66	8.64	8.62	8.59	8.58	8.57	8.55	8.55	8.54	8.53	8.53	.05	
26.9	26.7	26.6	26.5	26.4	26.4	26.3	26.2	26.2	26.2	26.1	26.1	.01	
2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	.25	
3.87	3.84	3.83	3.82	3.80	3.80	3.79	3.78	3.78	3.77	3.76	3.76	.10	4
5.86	5.80	5.77	5.75	5.72	5.70	5.69	5.66	5.66	5.65	5.64	5.63	.05	
14.2	14.0	13.9	13.8	13.7	13.7	13.7	13.6	13.6	13.5	13.5	13.5	.01	
1.89	1.88	1.88	1.88	1.88	1.88	1.87	1.87	1.87	1.87	1.87	1.87	.25	
3.24	3.21	3.19	3.17	3.16	3.15	3.14	3.13	3.12	3.12	3.11	3.10	.10	5
4.62	4.56	4.53	4.50	4.46	4.44	4.43	4.41	4.40	4.39	4.37	4.36	.05	
9.72	9.55	9.47	9.38	9.29	9.24	9.20	9.13	9.11	9.08	9.04	9.02	.01	
1.76	1.76	1.75	1.75	1.75	1.75	1.74	1.74	1.74	1.74	1.74	1.74	.25	
2.87	2.84	2.82	2.80	2.78	2.77	2.76	2.75	2.74	2.73	2.73	2.72	.10	6
3.94	3.87	3.84	3.81	3.77	3.75	3.74	3.71	3.70	3.69	3.68	3.67	.05	
7.56	7.40	7.31	7.23	7.14	7.09	7.06	6.99	6.97	6.93	6.90	6.88	.01	
1.68	1.6	1.67	1.66	1.66	1.66	1.65	1.65	1.65	1.65	1.65	1.65	.25	
2.63	2.59	2.58	2.56	2.54	2.52	2.51	2.50	2.49	2.48	2.48	2.47	.10	7
3.51	3.44	3.41	3.38	3.34	3.32	3.30	3.27	3.27	3.25	3.24	3.23	.05	
6.31	6.16	6.07	5.99	5.91	5.86	5.82	5.75	5.74	5.70	5.67	5.65	.01	
1.62	1.61	1.60	1.60	1.59	1.59	1.59	1.53	1.58	1.58	1.58	1.58	.25	
2.46	2.42	2.40	2.38	2.36	2.35	2.34	2.32	2.32	2.31	2.30	2.29	.10	8
3.22	3.15	3.12	3.08	3.04	2.02	3.01	2.97	2.97	2.95	2.94	2.93	.05	
5.52	5.36	5.28	5.20	5.12	5.07	5.03	4.96	4.95	4.91	4.88	4.86	.01	
1.57	1.56	1.56	1.55	1.55	1.54	1.54	1.53	1.53	1.53	1.53	1.53	.25	
2.34	2.30	2.28	2.25	2.23	2.22	2.21	2.19	2.18	2.17	2.17	2.16	.10	9
3.01	2.94	2.90	2.86	2.83	2.80	2.79	2.76	2.75	2.73	2.72	2.71	.05	
4.96	4.81	4.73	4.65	4.57	4.52	4.48	4.42	4.40	4.36	4.33	4.31	.01	

(*Continued*)

TABLE D.3 UPPER PERCENTAGE POINTS OF THE *F* DISTRIBUTION (*Continued*)

df for denominator N_2	Pr	df for numerator N_1											
		1	2	3	4	5	6	7	8	9	10	11	12
10	.25	1.49	1.60	1.60	1.59	1.59	1.58	1.57	1.56	1.56	1.55	1.55	1.54
	.10	3.29	2.92	2.73	2.61	2.52	2.46	2.41	2.38	2.35	2.32	2.30	2.28
	.05	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.94	2.91
	.01	10.0	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.77	4.71
11	.25	1.47	1.58	1.58	1.57	1.56	1.55	1.54	1.53	1.53	1.52	1.52	1.51
	.10	3.23	2.86	2.66	2.54	2.45	2.39	2.34	2.30	2.27	2.25	2.23	2.21
	.05	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.82	2.79
	.01	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.46	4.40
12	.25	1.46	1.56	1.56	1.55	1.54	1.53	1.52	1.51	1.51	1.50	1.50	1.49
	.10	3.18	2.81	2.61	2.48	2.39	2.33	2.28	2.24	2.21	2.19	2.17	2.15
	.05	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.72	2.69
	.01	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.22	4.16
13	.25	1.45	1.55	1.55	1.53	1.52	1.51	1.50	1.49	1.49	1.48	1.47	1.47
	.10	3.14	2.76	2.56	2.43	2.35	2.28	2.23	2.20	2.16	2.14	2.12	2.10
	.05	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.63	2.60
	.01	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	4.02	3.96
14	.25	1.44	1.53	1.53	1.52	1.51	1.50	1.49	1.48	1.47	1.46	1.46	1.45
	.10	3.10	2.73	2.52	2.39	2.31	2.24	2.19	2.15	2.12	2.10	2.08	2.05
	.05	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.57	2.53
	.01	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94	3.86	3.80
15	.25	1.43	1.52	1.52	1.51	1.49	1.48	1.47	1.46	1.46	1.45	1.44	1.44
	.10	3.07	2.70	2.49	2.36	2.27	2.21	2.16	2.12	2.09	2.06	2.04	2.02
	.05	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.51	2.48
	.01	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.73	3.67
16	.25	1.42	1.51	1.51	1.50	1.48	1.47	1.46	1.45	1.44	1.44	1.44	1.43
	.10	3.05	2.67	2.46	2.33	2.24	2.18	2.13	2.09	2.06	2.03	2.01	1.99
	.05	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.46	2.42
	.01	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.62	3.55
17	.25	1.42	1.51	1.50	1.49	1.47	1.46	1.45	1.44	1.43	1.43	1.42	1.41
	.10	3.03	2.64	2.44	2.31	2.22	2.15	2.10	2.06	2.03	2.00	1.98	1.96
	.05	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.41	2.38
	.01	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.52	3.46
18	.25	1.41	1.50	1.49	1.48	1.46	1.45	1.44	1.43	1.42	1.42	1.41	1.40
	.10	3.01	2.62	2.42	2.29	2.20	2.13	2.08	2.04	2.00	1.98	1.96	1.93
	.05	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.37	2.34
	.01	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.43	3.37
19	.25	1.41	1.49	1.49	1.47	1.46	1.44	1.43	1.42	1.41	1.41	1.40	1.40
	.10	2.99	2.61	2.40	2.27	2.18	2.11	2.06	2.02	1.98	1.96	1.94	1.91
	.05	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.34	2.31
	.01	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.36	3.30
20	.25	1.40	1.49	1.48	1.46	1.45	1.44	1.43	1.42	1.41	1.40	1.39	1.39
	.10	2.97	2.59	2.38	2.25	2.16	2.09	2.04	2.00	1.96	1.94	1.92	1.89
	.05	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.31	2.28
	.01	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.29	3.23

df for numerator N_1													df for denominator N_2
15	20	24	30	40	50	60	100	120	200	500	∞	Pr	
1.53	1.52	1.52	1.51	1.51	1.50	1.50	1.49	1.49	1.49	1.48	1.48	.25	
2.24	2.20	2.18	2.16	2.13	2.12	2.11	2.09	2.08	2.07	2.06	2.06	.10	10
2.85	2.77	2.74	2.70	2.66	2.64	2.62	2.59	2.58	2.56	2.55	2.54	.05	
4.56	4.41	4.33	4.25	4.17	4.12	4.08	4.01	4.00	3.96	3.93	3.91	.01	
1.50	1.49	1.49	1.48	1.47	1.47	1.47	1.46	1.46	1.46	1.45	1.45	.25	
2.17	2.12	2.10	2.08	2.05	2.04	2.03	2.00	2.00	1.99	1.98	1.97	.10	11
2.72	2.65	2.61	2.57	2.53	2.51	2.49	2.46	2.45	2.43	2.42	2.40	.05	
4.25	4.10	4.02	3.94	3.86	3.81	3.78	3.71	3.69	3.66	3.62	3.60	.01	
1.48	1.47	1.46	1.45	1.45	1.44	1.44	1.43	1.43	1.43	1.42	1.42	.25	
2.10	2.06	2.04	2.01	1.99	1.97	1.96	1.94	1.93	1.92	1.91	1.90	.10	12
2.62	2.54	2.51	2.47	2.43	2.40	2.38	2.35	2.34	2.32	2.31	2.30	.05	
4.01	3.86	3.78	3.70	3.62	3.57	3.54	3.47	3.45	3.41	3.38	3.36	.01	
1.46	1.45	1.44	1.43	1.42	1.42	1.42	1.41	1.41	1.40	1.40	1.40	.25	
2.05	2.01	1.98	1.96	1.93	1.92	1.90	1.88	1.88	1.86	1.85	1.85	.10	13
2.53	2.46	2.42	2.38	2.34	2.31	2.30	2.26	2.25	2.23	2.22	2.21	.05	
3.82	3.66	3.59	3.51	3.43	3.38	3.34	3.27	3.25	3.22	3.19	3.17	.01	
1.44	1.43	1.42	1.41	1.41	1.40	1.40	1.39	1.39	1.39	1.38	1.38	.25	
2.01	1.96	1.94	1.91	1.89	1.87	1.86	1.83	1.83	1.82	1.80	1.80	.10	14
2.46	2.39	2.35	2.31	2.27	2.24	2.22	2.19	2.18	2.16	2.14	2.13	.05	
3.66	3.51	3.43	3.35	3.27	3.22	3.18	3.11	3.09	3.06	3.03	3.00	.01	
1.43	1.41	1.41	1.40	1.39	1.39	1.38	1.38	1.37	1.37	1.36	1.36	.25	
1.97	1.92	1.90	1.87	1.85	1.83	1.82	1.79	1.79	1.77	1.76	1.76	.10	15
2.40	2.33	2.29	2.25	2.20	2.18	2.16	2.12	2.11	2.10	2.08	2.07	.05	
3.52	3.37	3.29	3.21	3.13	3.08	3.05	2.98	2.96	2.92	2.89	2.87	.01	
1.41	1.40	1.39	1.38	1.37	1.37	1.36	1.36	1.35	1.35	1.34	1.34	.25	
1.94	1.89	1.87	1.84	1.81	1.79	1.78	1.76	1.75	1.74	1.73	1.72	.10	16
2.35	2.28	2.24	2.19	2.15	2.12	2.11	2.07	2.06	2.04	2.02	2.01	.05	
3.41	3.26	3.18	3.10	3.02	2.97	2.93	2.86	2.84	2.81	2.78	2.75	.01	
1.40	1.39	1.38	1.37	1.36	1.35	1.35	1.34	1.34	1.34	1.33	1.33	.25	
1.91	1.86	1.84	1.81	1.78	1.76	1.75	1.73	1.72	1.71	1.69	1.69	.10	17
2.31	2.23	2.19	2.15	2.10	2.08	2.06	2.02	2.01	1.99	1.97	1.96	.05	
3.31	3.16	3.08	3.00	2.92	2.87	2.83	2.76	2.75	2.71	2.68	2.65	.01	
1.39	1.38	1.37	1.36	1.35	1.34	1.34	1.33	1.33	1.32	1.32	1.32	.25	
1.89	1.84	1.81	1.78	1.75	1.74	1.72	1.70	1.69	1.68	1.67	1.66	.10	18
2.27	2.19	2.15	2.11	2.06	2.04	2.02	1.98	1.97	1.95	1.93	1.92	.05	
3.23	3.08	3.00	2.92	2.84	2.78	2.75	2.68	2.66	2.62	2.59	2.57	.01	
1.38	1.37	1.36	1.35	1.34	1.33	1.33	1.32	1.32	1.31	1.31	1.30	.25	
1.86	1.81	1.79	1.76	1.73	1.71	1.70	1.67	1.67	1.65	1.64	1.63	.10	19
2.23	2.16	2.11	2.07	2.03	2.00	1.98	1.94	1.93	1.91	1.89	1.88	.05	
3.15	3.00	2.92	2.84	2.76	2.71	2.67	2.60	2.58	2.55	2.51	2.49	.01	
1.37	1.36	1.35	1.34	1.33	1.33	1.32	1.31	1.31	1.30	1.30	1.29	.25	
1.84	1.79	1.77	1.74	1.71	1.69	1.68	1.65	1.64	1.63	1.62	1.61	.10	20
2.20	2.12	2.08	2.04	1.99	1.97	1.95	1.91	1.90	1.88	1.86	1.84	.05	
3.09	2.94	2.86	2.78	2.69	2.64	2.61	2.54	2.52	2.48	2.44	2.42	.01	

(*Continued*)

TABLE D.3 UPPER PERCENTAGE POINTS OF THE *F* DISTRIBUTION (*Continued*)

df for denominator N_2	Pr	df for numerator N_1											
		1	2	3	4	5	6	7	8	9	10	11	12
22	.25	1.40	1.48	1.47	1.45	1.44	1.42	1.41	1.40	1.39	1.39	1.38	1.37
	.10	2.95	2.56	2.35	2.22	2.13	2.06	2.01	1.97	1.93	1.90	1.88	1.86
	.05	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.26	2.23
	.01	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.18	3.12
24	.25	1.39	1.47	1.46	1.44	1.43	1.41	1.40	1.39	1.38	1.38	1.37	1.36
	.10	2.93	2.54	2.33	2.19	2.10	2.04	1.98	1.94	1.91	1.88	1.85	1.83
	.05	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.21	2.18
	.01	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.09	3.03
26	.25	1.38	1.46	1.45	1.44	1.42	1.41	1.39	1.38	1.37	1.37	1.36	1.35
	.10	2.91	2.52	2.31	2.17	2.08	2.01	1.96	1.92	1.88	1.86	1.84	1.81
	.05	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.18	2.15
	.01	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18	3.09	3.02	2.96
28	.25	1.38	1.46	1.45	1.43	1.41	1.40	1.39	1.38	1.37	1.36	1.35	1.34
	.10	2.89	2.50	2.29	2.16	2.06	2.00	1.94	1.90	1.87	1.84	1.81	1.79
	.05	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.15	2.12
	.01	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12	3.03	2.96	2.90
30	.25	1.38	1.45	1.44	1.42	1.41	1.39	1.38	1.37	1.36	1.35	1.35	1.34
	.10	2.88	2.49	2.28	2.14	2.05	1.98	1.93	1.88	1.85	1.82	1.79	1.77
	.05	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.13	2.09
	.01	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.91	2.84
40	.25	1.36	1.44	1.42	1.40	1.39	1.37	1.36	1.35	1.34	1.33	1.32	1.31
	.10	2.84	2.44	2.23	2.09	2.00	1.93	1.87	1.83	1.79	1.76	1.73	1.71
	.05	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.04	2.00
	.01	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.73	2.66
60	.25	1.35	1.42	1.41	1.38	1.37	1.35	1.33	1.32	1.31	1.30	1.29	1.29
	.10	2.79	2.39	2.18	2.04	1.95	1.87	1.82	1.77	1.74	1.71	1.68	1.66
	.05	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.95	1.92
	.01	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.56	2.50
120	.25	1.34	1.40	1.39	1.37	1.35	1.33	1.31	1.30	1.29	1.28	1.27	1.26
	.10	2.75	2.35	2.13	1.99	1.90	1.82	1.77	1.72	1.68	1.65	1.62	1.60
	.05	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96	1.91	1.87	1.83
	.01	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.40	2.34
200	.25	1.33	1.39	1.38	1.36	1.34	1.32	1.31	1.29	1.28	1.27	1.26	1.25
	.10	2.73	2.33	2.11	1.97	1.88	1.80	1.75	1.70	1.66	1.63	1.60	1.57
	.05	3.89	3.04	2.65	2.42	2.26	2.14	2.06	1.98	1.93	1.88	1.84	1.80
	.01	6.76	4.71	3.88	3.41	3.11	2.89	2.73	2.60	2.50	2.41	2.34	2.27
∞	.25	1.32	1.39	1.37	1.35	1.33	1.31	1.29	1.28	1.27	1.25	1.24	1.24
	.10	2.71	2.30	2.08	1.94	1.85	1.77	1.72	1.67	1.63	1.60	1.57	1.55
	.05	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.79	1.75
	.01	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.25	2.18

df for numerator N_1													df for denominator N_2
15	20	24	30	40	50	60	100	120	200	500	∞	Pr	
1.36	1.34	1.33	1.32	1.31	1.31	1.30	1.30	1.30	1.29	1.29	1.28	.25	
1.81	1.76	1.73	1.70	1.67	1.65	1.64	1.61	1.60	1.59	1.58	1.57	.10	22
2.15	2.07	2.03	1.98	1.94	1.91	1.89	1.85	1.84	1.82	1.80	1.78	.05	
2.98	2.83	2.75	2.67	2.58	2.53	2.50	2.42	2.40	2.36	2.33	2.31	.01	
1.35	1.33	1.32	1.31	1.30	1.29	1.29	1.28	1.28	1.27	1.27	1.26	.25	
1.78	1.73	1.70	1.67	1.64	1.62	1.61	1.58	1.57	1.56	1.54	1.53	.10	24
2.11	2.03	1.98	1.94	1.89	1.86	1.84	1.80	1.79	1.77	1.75	1.73	.05	
2.89	2.74	2.66	2.58	2.49	2.44	2.40	2.33	2.31	2.27	2.24	2.21	.01	
1.34	1.32	1.31	1.30	1.29	1.28	1.28	1.26	1.26	1.26	1.25	1.25	.25	
1.76	1.71	1.68	1.65	1.61	1.59	1.58	1.55	1.54	1.53	1.51	1.50	.10	26
2.07	1.99	1.95	1.90	1.85	1.82	1.80	1.76	1.75	1.73	1.71	1.69	.05	
2.81	2.66	2.58	2.50	2.42	2.36	2.33	2.25	2.23	2.19	2.16	2.13	.01	
1.33	1.31	1.30	1.29	1.28	1.27	1.27	1.26	1.25	1.25	1.24	1.24	.25	
1.74	1.69	1.66	1.63	1.59	1.57	1.56	1.53	1.52	1.50	1.49	1.48	.10	28
2.04	1.96	1.91	1.87	1.82	1.79	1.77	1.73	1.71	1.69	1.67	1.65	.05	
2.75	2.60	2.52	2.44	2.35	2.30	2.26	2.19	2.17	2.13	2.09	2.06	.01	
1.32	1.30	1.29	1.28	1.27	1.26	1.26	1.25	1.24	1.24	1.23	1.23	.25	
1.72	1.67	1.64	1.61	1.57	1.55	1.54	1.51	1.50	1.48	1.47	1.46	.10	30
2.01	1.93	1.89	1.84	1.79	1.76	1.74	1.70	1.68	1.66	1.64	1.62	.05	
2.70	2.55	2.47	2.39	2.30	2.25	2.21	2.13	2.11	2.07	2.03	2.01	.01	
1.30	1.28	1.26	1.25	1.24	1.23	1.22	1.21	1.21	1.20	1.19	1.19	.25	
1.66	1.61	1.57	1.54	1.51	1.48	1.47	1.43	1.42	1.41	1.39	1.38	.10	40
1.92	1.84	1.79	1.74	1.69	1.66	1.64	1.59	1.58	1.55	1.53	1.51	.05	
2.52	2.37	2.29	2.20	2.11	2.06	2.02	1.94	1.92	1.87	1.83	1.80	.01	
1.27	1.25	1.24	1.22	1.21	1.20	1.19	1.17	1.17	1.16	1.15	1.15	.25	
1.60	1.54	1.51	1.48	1.44	1.41	1.40	1.36	1.35	1.33	1.31	1.29	.10	60
1.84	1.75	1.70	1.65	1.59	1.56	1.53	1.48	1.47	1.44	1.41	1.39	.05	
2.35	2.20	2.12	2.03	1.94	1.88	1.84	1.75	1.73	1.68	1.63	1.60	.01	
1.24	1.22	1.21	1.19	1.18	1.17	1.16	1.14	1.13	1.12	1.11	1.10	.25	
1.55	1.48	1.45	1.41	1.37	1.34	1.32	1.27	1.26	1.24	1.21	1.19	.10	120
1.75	1.66	1.61	1.55	1.50	1.46	1.43	1.37	1.35	1.32	1.28	1.25	.05	
2.19	2.03	1.95	1.86	1.76	1.70	1.66	1.56	1.53	1.48	1.42	1.38	.01	
1.23	1.21	1.20	1.18	1.16	1.14	1.12	1.11	1.10	1.09	1.08	1.06	.25	
1.52	1.46	1.42	1.38	1.34	1.31	1.28	1.24	1.22	1.20	1.17	1.14	.10	200
1.72	1.62	1.57	1.52	1.46	1.41	1.39	1.32	1.29	1.26	1.22	1.19	.05	
2.48	1.97	1.89	1.79	1.69	1.63	1.58	1.48	1.44	1.39	1.33	1.28	.01	
1.22	1.19	1.18	1.16	1.14	1.13	1.12	1.09	1.08	1.07	1.04	1.00	.25	
1.49	1.42	1.38	1.34	1.30	1.26	1.24	1.18	1.17	1.13	1.08	1.00	.10	∞
1.67	1.57	1.52	1.46	1.39	1.35	1.32	1.24	1.22	1.17	1.11	1.00	.05	
2.04	1.88	1.79	1.70	1.59	1.52	1.47	1.36	1.32	1.25	1.15	1.00	.01	

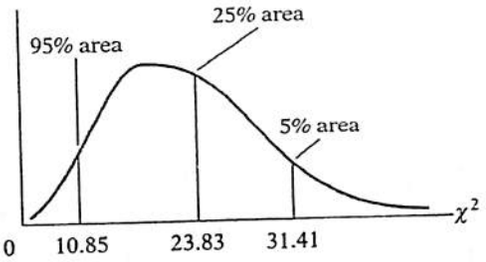
TABLE D.4 UPPER PERCENTAGE POINTS OF THE χ^2 DISTRIBUTION

Example

$\Pr(\chi^2 > 10.85) = 0.95$

$\Pr(\chi^2 > 23.83) = 0.25$ for df = 20

$\Pr(\chi^2 > 31.41) = 0.05$



Degrees of freedom \ Pr	.995	.990	.975	.950	.900
1	392704×10^{-10}	157088×10^{-9}	982069×10^{-9}	393214×10^{-8}	.0157908
2	.0100251	.0201007	.0506356	.102587	.210720
3	.0717212	.114832	.215795	.351846	.584375
4	.206990	.297110	.484419	.710721	1.063623
5	.411740	.554300	.831211	1.145476	1.61031
6	.675727	.872085	1.237347	1.63539	2.20413
7	.989265	1.239043	1.68987	2.16735	2.83311
8	1.344419	1.646482	2.17973	2.73264	3.48954
9	1.734926	2.087912	2.70039	3.32511	4.16816
10	2.15585	2.55821	3.24697	3.94030	4.86518
11	2.60321	3.05347	3.81575	4.57481	5.57779
12	3.07382	3.57056	4.40379	5.22603	6.30380
13	3.56503	4.10691	5.00874	5.89186	7.04150
14	4.07468	4.66043	5.62872	6.57063	7.78953
15	4.60094	5.22935	6.26214	7.26094	8.54675
16	5.14224	5.81221	6.90766	7.96164	9.31223
17	5.69724	6.40776	7.56418	8.67176	10.0852
18	6.26481	7.01491	8.23075	9.39046	10.8649
19	6.84398	7.63273	8.90655	10.1170	11.6509
20	7.43386	8.26040	9.59083	10.8508	12.4426
21	8.03366	8.89720	10.28293	11.5913	13.2396
22	8.64272	9.54249	10.9823	12.3380	14.0415
23	9.26042	10.19567	11.6885	13.0905	14.8479
24	9.88623	10.8564	12.4011	13.8484	15.6587
25	10.5197	11.5240	13.1197	14.6114	16.4734
26	11.1603	12.1981	13.8439	15.3791	17.2919
27	11.8076	12.8786	14.5733	16.1513	18.1138
28	12.4613	13.5648	15.3079	16.9279	18.9392
29	13.1211	14.2565	16.0471	17.7083	19.7677
30	13.7867	14.9535	16.7908	18.4926	20.5992
40	20.7065	22.1643	24.4331	26.5093	29.0505
50	27.9907	29.7067	32.3574	34.7642	37.6886
60	35.5346	37.4848	40.4817	43.1879	46.4589
70	43.2752	45.4418	48.7576	51.7393	55.3290
80	51.1720	53.5400	57.1532	60.3915	64.2778
90	59.1963	61.7541	65.6466	69.1260	73.2912
100*	67.3276	70.0648	74.2219	77.9295	82.3581

*For df greater than 100 the expression $\sqrt{2\chi^2} - \sqrt{(2k-1)} = Z$ follows the standardized normal distribution, where k represents the degrees of freedom.