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THE DARK MARKET OF FOREIGN EXCHANGE
THE POWER OF PURCHASING POWER PARITY

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Abstract

This thesis is an examination of foreign exchange markets, purchasing power parity and the exchange rates these two measures yield. An overview of the financial markets sets the tone of the first section of the thesis in which examples are given to show the derivation of market exchange rates. In section one, the foreign exchange market, market exchange rates and three currencies are defined and investigated. The overall magnitude of the forex market, the largest market in the world, is clearly defined throughout section one. The thesis continues on to section two where the concept of purchasing power parity is defined and derived mathematically. Following the initial discussion of PPP, the theoretical and relative PPP exchange rates are investigated. The two sections are then brought together with the concept of the law of one price and arbitrage. An ending hypothesis about the drastic difference between the market exchange rate and the theoretical PPP derived exchange rate being the fault of a lack of arbitrage in the global marketplace is made.

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Introduction

A persistent question has bugged many economists, financiers, and academics for years. This same question tugs at the minds of travelers and business owners, importers and exporters, and anyone who works with a currency other than their home currency. In the world we live in today, it is harder to escape foreign currencies than it is to find them working their way into your life. Foreign currency issues find their way to even the average consumer who has no idea she or he is being affected. So much of the world today is tied together by trade and currency exchange that so many facets of our lives depend on things like exchange rates or purchasing power. At this point, you are likely wondering what this nagging question about currency is and how does it even relate to you? Well, the question in plain English is, why does the same good cost a different price abroad than it does in my home country? There must be some explanation why I am buying the same thing and being charged a different price. I agree, there must be an explanation, but as an economic community, we have yet to come to a consensus.

The question posed above is written in a manner that the average consumer can easily digest. For anyone who has traveled abroad, they have surely wondered why they cannot just pay the same for their tall latte in the euro equivalent of their US dollars. In economic literature and extensive research, this fundamental question becomes more technical and begins to tie in two factors that we will explore here, the foreign exchange market setting market exchange rates and the purchasing power parity theory setting a theoretical exchange rate satisfying the law of one price. The problem explored here is the difference between the two, the market exchange rate and the theoretical PPP exchange rate. This query has been well researched and pondered over by countless economists and financiers, and we have yet to come to a consensus on why this difference exists.

There are two distinct parts of this thesis that are later connected by this very question. First, we will explore the foreign exchange market, taking a look at how it works, what it is made up of, and how investors partake in it. We will look at specific currencies at play in the market, and how those currencies are manipulated for profit. With this knowledge of the foreign exchange market, the foundation has been laid for your knowledge of where market exchange rates come from. Every consumer is in some way affected by these market exchange rates, whether it be purchasing imported bananas at the local grocery store or engaging in a retail market currency exchange prior to a trip to London. Understanding where market exchange rates come from allows for a connection later with the second portion of this thesis on purchasing power parity.

The roots of purchasing power parity, PPP, its uses, and its pitfalls are outlined in section two. With mathematical derivations and examples, you will have a practical understanding of purchasing power parity and how the theoretical PPP exchange rates are derived. Intuition will flow, as PPP exchange rates seem to make such perfect sense, but only to be questioned in the final section.

A possible explanation, relating to the law of one price and arbitrage, attempts to answer the question proposed at the beginning. The answer remains to be discovered, but this thesis aims to explore one avenue that accounts for why we are paying different prices for the same good at home and abroad.

Section I: Foreign Exchange Markets

According to the Central Intelligence Agency Factbook, there are nearly 178 currencies in use in the world today (Central Intelligence Agency, 2001). For many, the almighty dollar is the leader of them all, and they are in fact correct. The number one traded currency in the entire

world is the United States dollar (Gattis, 2010). But contrary to popular belief among many Americans, the U.S. dollar is not the only currency that makes our world go round. In fact, because of the roughly 177 other currencies in circulation we have the creation of the largest market in the world, the foreign exchange market (Luca, 2000). For those who have ever wondered what the intrinsic value of a U.S. dollar is, the foreign exchange market may be the answer to that lingering question. The power of money drives so many of the decisions we as a population make; an investigation of where the purchasing power that money has comes from is a worthwhile quest. Questions about what makes currency fluctuate from value to purchasing power all over the world will inevitably be left unanswered, but for now we seek to examine those fluctuations and see how different currencies make the world go round.

Section A. The Foreign Exchange Market

An informal survey of business students from one of the top public business programs in the country in the Smeal College of Business at the Pennsylvania State University shows a common misconception about the markets that rule some of the most developed nations in the world. The survey consisted of one question, asked verbally, what is the largest market in the world? When posed with this question, most students answered oil or some type of extractive market and, some even ventured to guess the stock market. As appalling as this may seem to anyone who has dabbled in foreign exchange, it makes apparent the common misconception about markets themselves. About.com's economic dictionary defines a market as the following, "A market is any place where the sellers of a particular good or service can meet with the buyers of that goods and service where there is a potential for a transaction to take place. The buyers must have something they can offer in exchange for a potential transaction to exist" (Moffat, 2010). You will often hear of people referring to markets using the adjective "free," meaning

that there is no government intervention or regulation and the economic foundations of supply and demand control the market. For our discussion, the foreign exchange market will fall into this category as a free market.

Now heading back to the question of the largest market in the world, as you may have come to the conclusion the correct answer is the foreign exchange market. The formal definition of the foreign exchange market is as follows,

Global market in which convertible currencies are traded and their conversion rates are determined. It is the world's largest financial market in which every day, on average, some one and one-half trillion dollars worth of currencies are bought and sold. Out of this only about 15 percent is traded for goods or services while the balance of 85 percent is traded by individual and institutional speculators (Business Dictionary, 2010).

That definition contains just bits and pieces of a wealth of knowledge about the foreign exchange market. So what is it that makes the foreign exchange market (also referred to as the forex market) the largest market in the world? Well that answer relies on the various uses of the foreign exchange market.

Prior to discussing the uses of the forex market, we should discuss some statistics of trading to capture the magnitude of the market. When referring to the forex market as the largest market in the world, this is in relation to the frequency and degree of trading currencies. The Bank for International Settlements collects data on the frequency of transactions in the global forex market, and then breaks the information down by type of transaction, currency, location etc. To grasp the scope of this market let us explore some of the major statistics focusing mainly on the currencies we will later explore. Last collected in April 2010, the average daily turnover in the global forex market in billions of US dollars was 3,981 (Bank of

International Settlements, 2010). This number represents a total of all financial instruments including swaps, spots, forwards, and other options (Bank of International Settlements, 2010). For the simplified examination of the global market frequency, we will consider the total of all transactions. A second statistic to consider is the percentage of total transactions associated with individual currencies. These percentages are based on 200% because two currencies are involved in each transaction and the sum of the individual percentage shares of each currency is 200 (Bank of International Settlements, 2010). Table 1 below illustrates the percent of total transactions associated with individual currencies. Notice that the US dollar accounts for roughly 42.4% of all transactions (based on 100% calculation), and the Euro and Pound are close behind with high percentages in the total transaction (Bank of International Settlements, 2010).

Table 1.

Currency	1998	2001	2004	2007	2010
US dollar	86.8	89.9	88.0	85.6	84.9
Euro	...	37.9	37.4	37.0	39.1
Pound sterling	11.0	13.0	16.5	14.9	12.9

*Note percentages based on 200% total.

(Bank of International Settlements, 2010)

Another statistic worth noting in relation to the global forex market is that the greatest currency transaction occurs between the euro and US dollar, accounting for 28% of all daily forex transactions (Bank of International Settlements, 2010). Finally, the United Kingdom is the geographical location for 36.7% of transactions and the United States for 17.9% of all transactions worldwide (Bank of International Settlements, 2010).

To solidify the discussion on the impact and scope of the forex market, it must be noted that the forex market is a 24-hour market. This means that currencies are traded 24 hours somewhere in the world. Table 2 below illustrates in Eastern Standard time that forex market

around the world are open 23 hours every business day. Although the market is not open from 4:00 pm until 5:00 pm, due to after hours trading and the extremely brief closing of the market, forex trading continues on with very little interruption.

Table 2.

Forex Market Time Converter

Time Zone: Eastern Standard Time

Forex Market Center	Time Zone	Opens <small>America/New_York</small>	Closes <small>America/New_York</small>
Frankfurt <small>Germany</small>	Europe/Berlin	03:00 AM <small>14-March-2011</small>	11:00 AM <small>14-March-2011</small>
London <small>Great Britain</small>	Europe/London	04:00 AM <small>14-March-2011</small>	12:00 PM <small>14-March-2011</small>
New York <small>United States</small>	America/New_York	08:00 AM <small>14-March-2011</small>	04:00 PM <small>14-March-2011</small>
Sydney <small>Australia</small>	Australia/Sydney	05:00 PM <small>13-March-2011</small>	01:00 AM <small>14-March-2011</small>
Tokyo <small>Japan</small>	Asia/Tokyo	07:00 PM <small>13-March-2011</small>	03:00 AM <small>14-March-2011</small>

(Time Zone Converter, 2011)

Section B: History of the Forex Market, Currency Volatility, and Market Investment

The forex market has roots going back to 1978, when currencies were allowed to float freely for the first time coming off of the gold standard (Luca, 2000). A free-floating currency is one of several types of currency systems, according to the International Monetary System, IMS. Free-floating allows the value or price of the currency to adjust to the supply and demand of that currency (Gattis, 2010). There is significant volatility with a currency that is allowed to float freely because it is subject to the constant fluctuation of supply and demand in the market. However, the free-float system allows for economic stability because the fluctuations happen gradually and immediately as the exchange rate responds to new information in the market, such as a change in supply or demand, this tends to decrease the possibility of a currency crisis or a

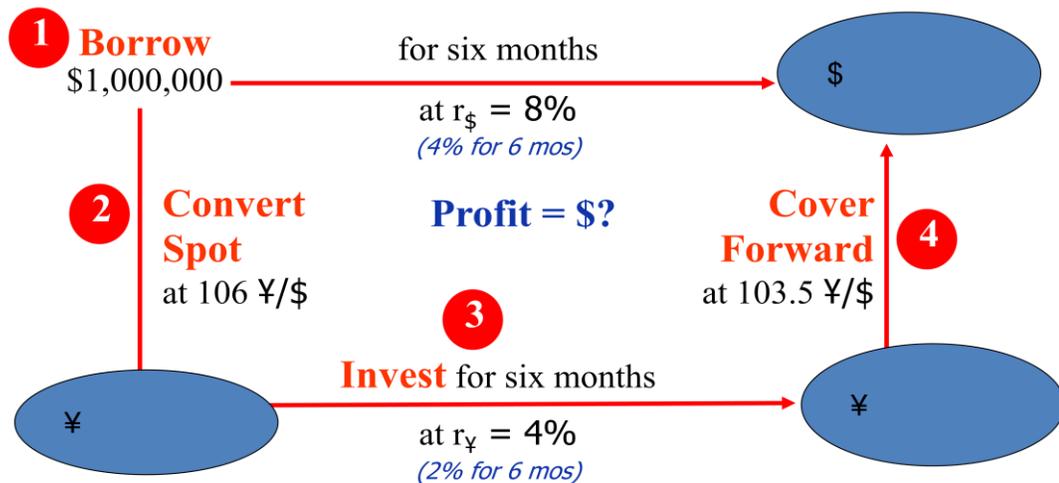
large shock, drop or spike, in currency value because it is adjusting gradually and not all at once to market conditions (Gattis, 2010). Currently, the United States Dollar, European Union Euro, and the Great Britain Pound Sterling among others use the free-float system and are among the top 10 highest traded currencies in the world (Shapiro and Sarin, 2009). Thus, with the increased use of a free-float system came the emergence of the forex market in the late 1970s. It was not until 1995 that the forex market was open to individual investors; prior to 1995 the market was reserved for banks and large multinational companies (Luca, 2000). However, today, thanks to the communication superhighway, individual investors can be just as active in the market as large banks and companies. These two participants in the forex market give rise to two of the main uses of this particular market.

International trade and investment have been steadily growing as the world economy has taken a turn towards a global market in the past half-century. The forex market plays a huge role in allowing banks and large multinational companies to participate in international trade and investment by facilitating the exchange of currencies. The market allows these banks and other parties to buy and sell currencies depending upon their needs. As the definition of a market suggests, the forex market brings together participants, buyers and sellers, from literally all ends of the world to exchange their currencies. Being that the exchange market is global, the number of participants is fundamental reason why this market is so large.

Following 1995, the introduction of individual investors into the forex market led to a second primary use of the forex market. Unlike large corporations, individuals are not using the forex market on the same level to engage in transactions such as swaps, options, or futures. The average individual, someone going on vacation for example, will exchange a reasonable amount of currency, compared to large investors trading in the high thousands or millions, on the retail

forex market either at a kiosk in an airport, for example, or directly from a forex automated teller machine, such as Travelex. The situation just explained is common for international travelers who are one of the main consumers on the retail forex market. A second scenario is the individual investor who uses the forex market to profit from their trades, as seen primarily in a carry trade. A carry trade is one in which you borrow a currency which has a low interest rate of borrowing and invest in a currency which has a high rate of interest or synonymously a high yielding rate of return. (Gattis, 2010). The interest rates associated with the currency refer to the interest either paid while borrowing the money or earned while investing the money. Different currencies have different rates for borrowing and investing. These rates, both borrowing and investing, are associated with state of each country's economy and are subsequently set by the borrowing and investing institutions. For example, a borrowing rate from a United States based bank will be set according to the lending nature in that country at the time borrowing is being requested. Therefore, since that bank is based in a specific country it will be denominated in that country's home currency making different currencies and country's have different borrowing and investing rates. Thus, you will want to borrow at a lower interest rate and invest at a higher one. The most common form this is practiced in is through covered interest arbitrage. Arbitrage is the practice of exploiting price differences in order to make a profit (Shapiro and Sarin, 2009). Arbitrage is regularly seen in foreign exchange. Due to the massive fluctuation in regularly traded currencies, arbitrage opportunities are available constantly although typically for only seconds maybe minutes at a time. Figure 1 below illustrates a typical covered interest arbitrage in which the investor profits as long as the borrowed currency does not appreciate, increase in price, and the investment does not depreciate, decrease in value.

Figure 1.



(Gattis, 2010)

A specific example of a carry trade will shed light on the figure above. This example will involve a Swiss Franc US dollar carry trade. We start off with an initial sum of money, 1,000 SF, and convert that using the spot market exchange rate, \$0.8918 /SF, to get \$891.80. We then invest the \$891.80 earning a 10% annual return so that we have \$980.98 at the end of 1 year. We then must cover the loan that we took out originally but to do that we must convert back to Swiss Francs. We convert back using a forward rate, because this is 1 year from the initial borrowing, of \$.8942 and we get 1097.05 SF. We must now subtract the initial amount borrowed that was charged an interest rate of 6% annually. Thus, $6\% * 1,000 \text{ SF} = 1060$. Therefore the difference of 37.05 SF represents our profit made from the carry trade. This seems like a small number, but the trades are typically done with hundreds of thousands of dollars and in that case the profits are massive. This is an example of arbitrage, which we will later see has a direct relationship with purchasing power parity and real market exchange rates.

Section C. Currencies

As noted earlier, the world is home to nearly 200 currencies based on 2001 data (Central Intelligence Agency, 2001). But, just as the world has superpower nations, the world has superpower currencies as well. Without a doubt, the United States dollar is the most traded currency in the entire world, and it far surpasses the next highest traded currencies. The top five trading currencies according to the Bank of International Settlements 2001 data are the US dollar, Euro, Japanese Yen, Pound Sterling, and the Swiss Franc (Bank of International Settlements, 2010). These currencies are typically referred to as hard currencies for their buying power throughout the world. The term hard currencies is applied to currencies that can be easily obtained through the exchange and generally accepted to purchase most goods (Shapiro and Sarin, 2009). Hard currencies are known for their stability and are considered to have a solid store of value.

The opposite of a hard currency is a soft currency. For example, the Philippines peso is a soft currency that is not easily traded on the foreign exchange market (Shapiro and Sarin, 2009). A common disadvantage of soft currencies is that they are not accepted for purchase at many places. The most modern example of this may be an Internet purchasing engine such as Amazon. Amazon operates in many different countries, but accepts only payments tied to hard currencies and only prices using hard currencies as well. Individual holders of soft currencies who may be traveling or wishing to purchase something priced in a hard currency such as the Euro may face high, unfavorable exchange rates on the retail exchange market due to the instability of their home currency. Thus, to compare purchasing power, as we will do here, the focus will stay on three of the hard currencies: the U.S. dollar, Euro, and Pound Sterling.

Of our three currencies, the U.S. dollar is the most recognizable currency throughout the world. The home base of the U.S. dollar is, of course, the United States of America. It was 1786 when Congress approved the dollar that we know and love today (U.S. Treasury, 2008). Since then, the United States dollar has taken on the most powerful role possible in the world economy. The U.S. dollar is traded under the abbreviation USD (Yahoo Finance, 2010). Not only is the dollar the most abundant currency in the world, but it is also arguably the most recognized piece of paper. The United States has a free-float system with occasional intervention, should we be in danger of a crisis, allowing the dollar's value to respond to changes in supply and demand (Gattis, 2010). This free-float system with occasional intervention is sometimes referred to as a hybrid free-float system (Gattis, 2010). The U.S. dollar is regarded as one of the most stable currencies, meaning it is at low risk for a currency crisis and low risk for default, although it is no longer backed by the gold standard. The value of the U.S. dollar is, as all other major currencies, determined by the foreign exchange market. In subsequent chapters, we will begin to explore the differences in not only the intrinsic value of the dollar in the United States, but also its purchasing power abroad.

The euro has caught the eye of the world, as it became the home currency in the Euro zone. The actual name *euro* was adopted in 1995, while the financial markets recognized the euro in 1999 and it began circulation with the public in 2002 (Hermes, 2010). The most recent of our currencies in question, the euro, has become the second-highest currency traded following the U.S. dollar (Gattis, 2010). Currently, 16 of the 27 members of the European Union are part of the Euro zone in which the euro is the sole tender (Hermes, 2010). The euro is traded under the abbreviation of EUR (Yahoo Finance, 2010). Similar to the dollar, the euro operates with a hybrid free-float system with occasional government intervention. Currently, Ireland is in

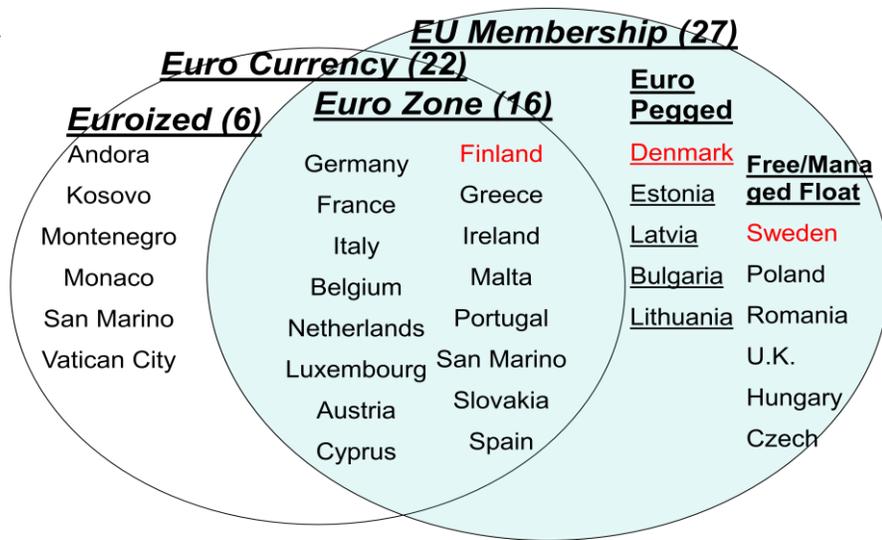
danger of government intervention to offset a possible devaluation of the euro due to poor economic conditions and high default risk in the country. This brings up the important difference between the U.S. dollar and other internationally recognized currencies. Unlike the U.S. dollar which is unique and attached solely to the United States of America, the euro belongs to not one sole country, but rather, to a region of the world. There are 16 countries currently calling the euro their home currency and more will likely be added in the future, as there are 27 total countries in the European Union. Currency value is largely affected by the economic health of the home country. Thus, there is evidence that a healthy country is likely to have a stronger currency value than a country that is unstable and at risk of default (Shapiro and Sarin, 2009). That is to say, if a country is likely to default, be unable meet its financial obligations, its currency will hold less value in the forex market. Financial health of a country is measured using a wealth of indicators, and being that the value of the euro is tied to 16 different countries, there is significantly more exposure to a decrease in financial health of a given country. This was most recently seen in Greece, where the Greek financial crisis had a potential to have great effect on the value of the euro. This increased exposure to declining financial health makes the euro valuation quite different from that of the United States dollar. Certainly, this is something that will have an effect on the later examination of the purchasing power of the euro abroad.

The oldest currency in our examination is the pound sterling, most commonly referred to as the pound; it is the home currency of the United Kingdom. The pound sterling is the oldest currency that is still in use with origins dating back to the Anglo-Saxon era (Bank of England, 2010). Famously known as the currency picturing the royal family, the pound is exchanged on the forex market under the abbreviation GBP (Yahoo Finance, 2010). The pound is commonly the highest-valued of the three currencies under examination here, although it high-valued and

considered stable, at low risk for a currency crisis, it is still subject to constant fluctuations due to its hybrid free-float system. The pound sterling is similar to the euro in that it is the home currency to more than one country, including 8 British territories (Bank of England, 2010). This increases its risk similar to the euro but to a much less extent. Behind the euro, U.S. dollar, and Japanese yen, the pound sterling is the fourth highest-traded currency in the world. The pound sterling, holding one of the highest exchange values, has been regarded traditionally as one of the most expensive currencies in the forex market. This alludes to an interesting examination of the purchasing power of the pound sterling to be investigated in following chapters.

Figure 2 below shows the European Economic Area and the euro listing the 16 nations currently in the Euro zone claiming the euro as their home tender.

Figure 2.



(Gattis, 2010)

When examining international monetary systems, there are areas of the world that use the euro but are not part of the euro zone and do not report or have representation in the European

Central Bank. These areas are referred to as Eurodized and as seen in Figure 2 contain countries such as Vatican City (Gattis, 2010). A similar term, dollarized, refers to countries that adopt the dollar rather than their own domestic currency (Nicholson, 2010). This refers to any country that uses a “dollar” currency that is not their own or in other words pegs their currency to the U.S. dollar. These are just two examples of the many currency issues that exist around the world.

The foreign exchange market overview provided here seeks to supply a working knowledge of how the market sets market exchange rates. These market exchange rates will relate later to theoretical exchange rates derived using the purchasing power parity theorem. The forex market is largely unregulated, which tends to lead to pitfalls throughout the market, one of which we will see later in relation to exchange rates. From this description, it is important to take away how exchange rates come to be since they are so very important in pricing around the world. The forex market is not only the largest market, but it controls the exchange rates and essentially gives value to the money that we use to survive. The forex market is essential in assigning the purchasing power of currency, although we will see in the next section, this purchasing power comes with a lot of debatable issues.

Section II: Purchasing Power Parity

Purchasing power parity (PPP) is a concept that has raised questions for economists, financiers, and non-academics alike concerned with international trade, monetary policy between countries, and international finance, to name only a few. Countless research and modifications have been made to both the theory and calculation of PPP. To the financial guru, the currency trader, the budding economist, or the average consumer, PPP has some relevant use in answering their questions about international commerce, but also raises its own share of concerns. First and foremost, what exactly is PPP, and how do we go about using it? Answering these questions is

the fundamental step to understanding why economists and researchers are attracted to the model of PPP and why PPP theory deviates from observed real exchange rates.

Section A: Theoretical Explanation of PPP

Let us start with the raw definition of theoretical PPP and then turn to the actual calculations. PPP theory surmises that in the long run, identical bundles of goods and services should cost the same in different countries due to adjustments in exchange rates to eliminate arbitrage (Investopedia, 2010). Arbitrage relevant in this context is the act of buying a good in one country and selling it in another for a higher price. Recall earlier we defined arbitrage, as taking advantage of price differences; here is a more example specific definition. Another simplified definition of theoretical PPP is the amount of adjustment needed in an exchange rate in order for the price of two identical bundles of goods to have the same purchasing power in two different countries (Investopedia, 2010). PPP theory is primarily used for comparison purposes and even further for international comparison projects (World Bank, 2009). Mark and Alan Taylor define PPP as the following, “The general idea behind purchasing power parity is that a unit of currency should be able to buy the same basket of goods in one country as the equivalent amount of foreign currency, at the going exchange rate, can buy in a foreign country, so that there is parity in the purchasing power of the unit of currency across the two economies” (Taylor and Taylor, 2004, 4). Before continuing on, an explanation of the notion of purchasing power, this “bundle of goods,” the law of one price and consumer price index is necessary.

The words purchasing and power in and of themselves explain the majority of what the term means. An example using the United States dollar will help explain. Take \$2.00 in United States currency. That two dollars itself has minimal utility for its consumer unless it is used to purchase a good or service. The purchasing power of that dollar is what it is able to buy you. As

a coffee drinker, my average coffee costs between \$1.50 and \$2.00 depending on whether I indulge in Dunkin Donuts or Starbucks that given day. The purchasing power of my \$2.00 is, on most occasions, worth a cup of coffee. Now, certainly you can substitute for that good, in this case coffee, with anything that you the consumer may find a higher utility in than the two one dollar bills. Now to complicate things, and the reason why we have PPP, if you were to exchange that two dollars over to euros, the calculation would look like the following:

Indirect exchange rate: EUR/USD (\$/€) 1.3613

$$\$2 \times (\text{€}1 / 1.3613 \$) = 1.4692 \text{ €}$$

(Yahoo Finance, 2011)

What this calculation tells us is that for the same good, a \$2.00 cup of coffee in the United States, we would need 1.47 € to make the purchase of an identical good in the European Union. So the purchasing power of 1.47 € is a cup of coffee, in this example, in a euro denominated country. This simple example only seeks to explain the notion of purchasing power from a theoretical point of view; later in our investigation we will find conflicts where purchasing power differs dramatically among nations.

A second concept to address before continuing on with the fundamentals of PPP is this concept of a bundle of goods. Most intro economics classes use this notion of a bundle of goods, often with little explanation of what might be in the bundle of goods. But this bundle of goods is not to be taken so literally. A literalist interpretation of a bundle of goods often asks, are these normal goods, inferior goods, non-tradeable goods, tradeable goods, or services too? These questions also arose recently in an interview when US Congressman Paul Ryan mentioned the idea of backing the U.S. dollar with a bundle of goods, similar to the no longer used gold standard. This bundle of goods that most economics professors, and apparently now economists

writing on the stability of the U.S. dollar, use with often little explanation relies on the Samuelson model of consumer behavior (Deaton et al., 2010). The bundle of goods in question is representative of consumer preferences and therefore reflects consumer buying habits (Britannica Encyclopedia, 2011). Although the bundle of goods cannot be defined in definite terms, here we will assume for our calculations that it is both identical and representative of consumer preferences and therefore sufficient for calculations and comparison among countries using the currencies we have defined. There is much debate about assigning this bundle of goods particularly when it comes to cross-country comparisons. I mentioned that the bundle of goods may not be a “definite” bundle in the sense that the specific inputs can be accounted for among the different countries, but rather, the bundle is representative of similar goods and services consumed in the two locations.

The law of one price constantly shows up as a foundation for studying PPP. As Suranovic explains, the law of one price states “that identical goods should sell for the same price in two separate markets when there are no transportation costs and no differential taxes applied in the two markets” (2010). PPP therefore is an extension of the law of one price to the aggregate, while also taking into account different exchange rates in order to compare purchasing power internationally (Suranovic, 2010). The law of one price calculation will be seen later when we mathematically show PPP.

PPP is often associated with the consumer price index. The consumer price index (CPI) is a measure of living costs based on a bundle of goods that we defined above (Britannica Encyclopedia, 2010). Note that in much textbook writing about the CPI, the bundle of goods is referred to as a market basket. This calculation measures changes in the costs of living. Inflation, which consists of increases in prices, results in a rise of the CPI (Suranovic, 2010). The

relationship that exists is that inflation causes the rise in prices making up CPI and it is this increase in CPI that we use to compare price differences across time. In economics classes and my experience thus far, the CPI is commonly used in comparing social security from one year to the next to account for inflation. The CPI is also used to compare what it costs to live in a given area for a certain year. That is purely theoretical and used for pedagogical purposes, the real adjustments are far more involved although they do take into account changes in the CPI. We also use the CPI in calculations of nominal to real rates. One of the practical applications commonly taught is the movement from nominal to real wages. An example will clarify this point. Suppose you are deciding whether to live in Boston, Massachusetts or Chicago, Illinois and both are offering a salary of \$60,000 per year. To calculate the real wage, or the wage that is adjusted for inflation, we divide the nominal wage (\$60,000) by the CPI and then multiply that value by 100 (Mankiw, 2009). For Boston, the CPI as of January 2011 was 240.54 with a base year of 1982-1984 (U.S. Bureau of Labor Statistics, 2011). Thus, the real wage is equal to $(\$60,000/240.54)*100$ or \$24,944. The CPI for urban wage earners in Chicago as of January 2011 is 215.16 with the same base year 1982-1984 (U.S. Bureau of Labor Statistics, 2011). Using the same calculation as before that makes the real wage in Chicago equal to \$27,886. With this simple calculation we can see that the purchasing power or real wage is higher in Chicago. Therefore, if the consumer were indifferent to living in Chicago or Boston then based on real wage, he would earn a higher real wage in Chicago and likely chose to work there.

In relation to PPP, the CPI can be used to derive a theoretical PPP given two countries with the same base year (Suranovic, 2010). As seen, the CPI and PPP both use a bundle of goods for consumers and therefore the CPI and PPP can be manipulated mathematically to

compare two countries' purchasing power (Suranovic, 2010). The CPI to PPP formula is derived as follows:

The CPI for year YY, the year in which the prices prevail, with base year 1990 is where, CB = cost of the market basket and $CPI_{90} = 100$ because $CPI_{90} = (CB_{90}/CB_{90}) \times 100$. We are solving for the CPI in year YY as follows:

$$CPI_{YY} = (CB_{YY}/CB_{90}) \times 100$$

In order to use the CPI to get a theoretical PPP we must consider one year and two currencies. From this we will get the PPP exchange rate for the euro and the dollar in 2009.

The CPI PPP relationship in year 2009 between U.S. \$ and European Union Euro: First the formula below shows how we derive the CPI for the two currencies using the CB of each currency in 2009 and the base year 2008; the blue and purple portions show the equivalent calculations of CPI for year 2009 using the two currencies with the base year being 2008. The blue and purple are the intermediate steps to arrive at the orange equation; all of the portions are equal. The steps in blue and purple are algebraically manipulated to result in the orange equation, which will be used for the PPP derivation next.

$$\begin{aligned} (CPI_{09\text{€}}/CPI_{09\$}) &= (CB_{09\text{€}}/CB_{08\text{€}})/(CB_{09\$}/CB_{08\$}) = (CB_{09\text{€}}/CB_{09\$}) \times (CB_{08\$}/CB_{08\text{€}}) = (CB_{09\text{€}}/CB_{09\$})/(CB_{08\text{€}}/CB_{08\$}) \\ &= \\ &= (CPI_{09\text{€}}/CPI_{09\$}) = (CB_{09\text{€}}CB_{09\$})/(CB_{08\text{€}}CB_{08\$}) = (({}^{09}E^{PPP}_{\text{€}/\$})/({}^{08}E^{PPP}_{\text{€}/\$})) \end{aligned}$$

E^{PPP} represents the PPP-derived exchange rate for the given currencies.

We can then rearrange the formulas using basic algebra to equal the PPP exchange rate for the 2009 Euro/USD PPP exchange rate showing its relation to CPI:

$$= {}^{09}E^{PPP}_{\text{€}/\$} = {}^{08}E^{PPP}_{\text{€}/\$} \times CPI_{09\text{€}}/CPI_{08\$}$$

Where, ${}^{08}E^{PPP}_{\text{€}/\$}$ represents the PPP exchange rate that prevails in the base year, 2008, between the two countries.

(Suranovic, 2010)

Now that we have touched on the basis of the theoretical framework of PPP, we can move on to the mathematical calculations involved with using the PPP framework. These calculations can vary depending on the data you have available and your use of said data.

Although several methods will be outlined, later empirical statistics will reveal the methods chosen for answering the questions relating specifically to my research.

Section B: Mathematical Formulas of PPP

The basic calculations for PPP, as seen in most international finance courses, are shown below. We are taking the cost of a good in one country and the cost of a good in another country and dividing them (Gattis, 2010b). What this gives us is the theoretical exchange rate based on the notion of PPP. The exchange rate that comes out satisfies the PPP theory in that it would make the price of two identical goods equal in different countries. This is referred to as the absolute PPP. However, research shows that absolute PPP is rarely observed in the market. In other words it is unlikely that you will find currencies traded in the forex market at the absolute PPP exchange rate. There are many factors that contribute to why we do not trade currencies at the absolute PPP exchange rate in the foreign exchange rate market, and that is what we will later investigate.

A second formula for PPP is the relative PPP. Relative PPP takes into account changes in prices (Gattis, 2010b). The formula is similar to absolute PPP, but addressing price fluctuation resulting from inflation. Relative PPP can also be found below. For now, mathematically we can derive an exchange rate to satisfy the PPP theory, both with and without changes in prices, using the following formulas:

Absolute PPP, where $e_0^{h/f}$ is the exchange rate reflecting relative prices of goods in two countries, home and foreign (Gattis, 2010b)

$$e_0^{h/f} = \frac{\text{Price}_h}{\text{Price}_f}$$

Absolute PPP suggests that the price, in the countries' home currency, is exactly identical in two different locations. As seen here, there are no other variables taken into account to arrive at the theoretical PPP exchange rate. Research has shown that this absolute or theoretical PPP exchange rate does not hold and therefore currencies are either overvalued or undervalued. We will address this in an example later.

Relative PPP, where $e_1^{h/f}$ is the exchange rate adjusted to reflect purchasing power in any currency. $e_0^{h/f}$ where e_0 are the relative prices in the two countries.

$$e_1^{h/f} = e_0^{h/f} \frac{1 + i_h}{1 + i_f}$$

(Gattis, 2010b)

In the relative PPP equation shown above, the terms i_h and i_f are the inflation factors taken into account that prices rise according to inflation. The relative PPP equation is adjusted similar to the nominal and real calculations of salary that were examined earlier. PPP-derived exchange rates differ from market-based exchange rates, as we will see shortly in our analysis.

PPP rates are based on calculations such as those done above using relative and absolute prices. The international comparison program (ICP), managed by the World Bank, is one of the most heavily used research instruments relating to PPP. As mentioned, PPP is used as a comparison tool, often for international queries. The ICP uses PPP rates in conjunction with a variety of different economic indicators allowing for comparisons across countries. Some of the ICP data include GDP (gross domestic product) PPP, GDP per capita PPP, GNI (gross national income) PPP, and household final consumption PPP, to name a few (World Bank, 2009). ICP makes a level playing field for the specific economic indicator being represented. What that means is we take GDP per capita and convert it into international dollars using PPP rates so that we can accurately compare GDP per capita from different countries for a wide variety of

research (World Bank, 2010). ICP is one of the main sources of data for the investigation of the euro, U.S. dollar, and pound sterling that we will see shortly.

Section C: Uses of PPP

PPP is an economic indicator with uses far beyond simple comparison. PPP is typically such a simple calculation that it can be used at both the international and regional levels. Here, I would like to highlight some of the uses of PPP to indicate its widespread acceptance, followed by an example before addressing its drawbacks. The table below indicates the various regional and international uses of PPP and the organization that conducts the research. From this table, one can see that PPP is not only used in the context of forex and exchange rates, but clearly for much economic research. Although PPP has its faults, outlined in section E: pitfalls of PPP, it remains a useful tool in international comparisons and regional comparisons. Table 3 justifies PPP as a useful method of comparison between theoretical and actual exchange rates because of its widespread use and the large amount of available data.

Table 3.

Organization	Use of Purchasing Power Parity
World Bank	<ul style="list-style-type: none"> • International poverty headcount index
International Monetary Fund (IMF)	<ul style="list-style-type: none"> • Comparing relative sizes of economies and estimating weighted averages of regional growth rates
<i>European Commission</i>	<ul style="list-style-type: none"> • Allocation of structural and cohesion funds
<i>United Nations Development Programme (UNDP)</i>	<ul style="list-style-type: none"> • Gender empowerment measures • Human Development Index
World Health Organization	<ul style="list-style-type: none"> • Health inequality assessment
U.N. Educational, Scientific and Cultural Organization	<ul style="list-style-type: none"> • Assessing per capita expenditures in education
U.N. Children's Fund	<ul style="list-style-type: none"> • Monitoring the welfare of children
International Organizations	<ul style="list-style-type: none"> • Designing effective aid programs
Policy Makers	<ul style="list-style-type: none"> • Analysis of an economy's comparative advantage on prices and expenditures of goods or services
Multinational Corporations, Non-Government Organizations, International Development Agencies	<ul style="list-style-type: none"> • PPP adjusted cost of living allowances
Other	<ul style="list-style-type: none"> • Evaluation of investment costs and industry growth potential across countries

Section D: An Example of PPP

Before delving into empirical data and the specific study relating to the three currencies discussed above, let us walk through an example of PPP and its use in comparing two different countries to ensure a firm understanding. For this example we will be comparing the GDP per capita of two countries. A common problem when comparing GDP per capita using a market exchange rate rather than a PPP rate is that the GDP per capita difference tends to be overestimated in favor of the more developed nation. This is seen especially when comparing a developed versus undeveloped nation where the composition of GDP, tradeable versus non-tradeable goods, tends to be quite different for the two countries (Suranovic, 2010). The problem here lies with the exclusion of non-tradeable goods from the market exchange rate. By not including non-tradeable goods, which for some countries makes up a large portion of their GDP,

we get skewed results when comparing the different countries (Moss, 2010). By using the PPP exchange rate, which does take into account the non-tradeable portion of a country's GDP, the differences in GDP per capita are more accurate. The distinction between tradeable and nontradeable goods can vary depending on the country and good, and the barrier between the two types of goods has become blurry in recent years with massive technological advancements. For example, in past years setting an appointment for a real estate showing was something done between the buyer and seller or their agents. Now we have a service that sets the appointments for the agent and buyer, but because of advancements in technology (particularly computers and telephones) that company no longer needs to be based in the same country as the buyer or agent. There will always be non-tradeable goods such as services (like getting a haircut), so the gap will never entirely close. PPP rates take into account both tradeable and non-tradeable goods giving us a more accurate exchange rate to compare countries' GDP per capita (Moss, 2010).

Now let us examine a use of PPP in international comparison to show the issues that may arise with pure GDP per capita comparison. We have two countries here, Rich and Poor. Each country has its own domestic currency. Rich uses dollars denoted by the symbol \$ while poor uses tokens denoted by the symbol \mathcal{T} . We have a bundle of goods representing a set of goods in both countries. Note that, as defined before, these goods are identical in both countries for comparison purposes. The price of the bundle in Rich is 10\$, and the price of the bundle in Poor is $43\mathcal{T}$. Thus, we can compare the two countries' GDP per capita in one currency using the PPP exchange rate. We must first equate the two using the following formula: $10\$ \times e^{\text{PPP}} \mathcal{T}/\$ = 43\mathcal{T}$. By solving this we get the PPP exchange rate equal to $e^{\text{PPP}} 4.3\mathcal{T}/\$$. Now supposing that the market exchange rate is $10 \mathcal{T}/\$$ and Rich has \$4 we can calculate that Rich's GDP in Poor's currency will be: $\text{GDP}_{\text{Rich}} = 10\$ \times e^{\text{PPP}} \mathcal{T}/\$ = 172\mathcal{T}$. We can now compare the GDP of both

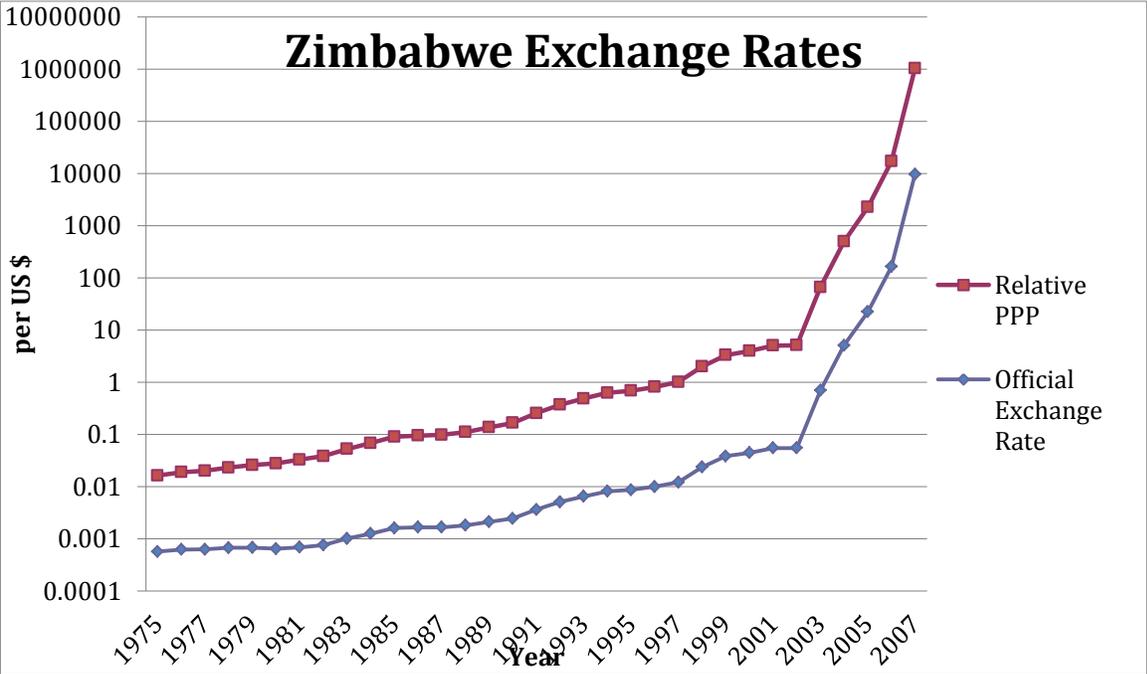
countries in a common currency that we have adjusted based on PPP to include both tradeable and non-tradeable goods. The calculation is as follows: $(GDP_{\text{Rich}}/GDP_{\text{Poor}}) = 172/43 = 4$. The conclusion is that Rich's GDP is four times greater than Poor's economy. This method using the PPP exchange rate allows for a more accurate conclusion about the gap in GDP of the two countries. Had we only taken into account the market rate of exchange we would likely find the difference of GDPs to be overstated. This is true because market exchange rates do not take into account non-tradeable goods. By ignoring non-tradeable goods, which we assumed made up a large portion of Poor's GDP, we were undervaluing the GDP in Poor in relation to the GDP in rich. This brief example highlights the differences in using the market exchange rate versus the PPP derived exchange rate. Later we will explore other issues that arise due to this difference.

Section E: Pitfalls of PPP

As illustrated thus far, PPP seems to be a great tool for international comparisons and various other queries. However, as good as PPP is, there are several drawbacks to the model that must be taken into account. As highlighted earlier, there are two types of PPP: the absolute and relative PPP. These two types of PPP take into account the levels of change in prices. Between the two we have concluded that relative PPP adjusts for inflation while absolute PPP considers only relative price comparisons. An example will explain relative PPP the best. Suppose you have an identical good in the United States and England. The good costs \$5 in the U.S. and 6£ in England. The absolute PPP would be $\$5/6\text{£} = \$/\text{£} .83$. If the prices of the goods changed, due to inflation, to \$5.50 and 7£ then the PPP would adjust to a relative PPP and would be $\$5.50/7\text{£} = \$/\text{£} .79$. This adjustment in PPP to account for changes in price is the difference between absolute and relative PPP. The graphs below illustrate the relation of relative PPP to the actual exchange rate. The two countries, Zimbabwe and Zaire, are known for high rates of inflation

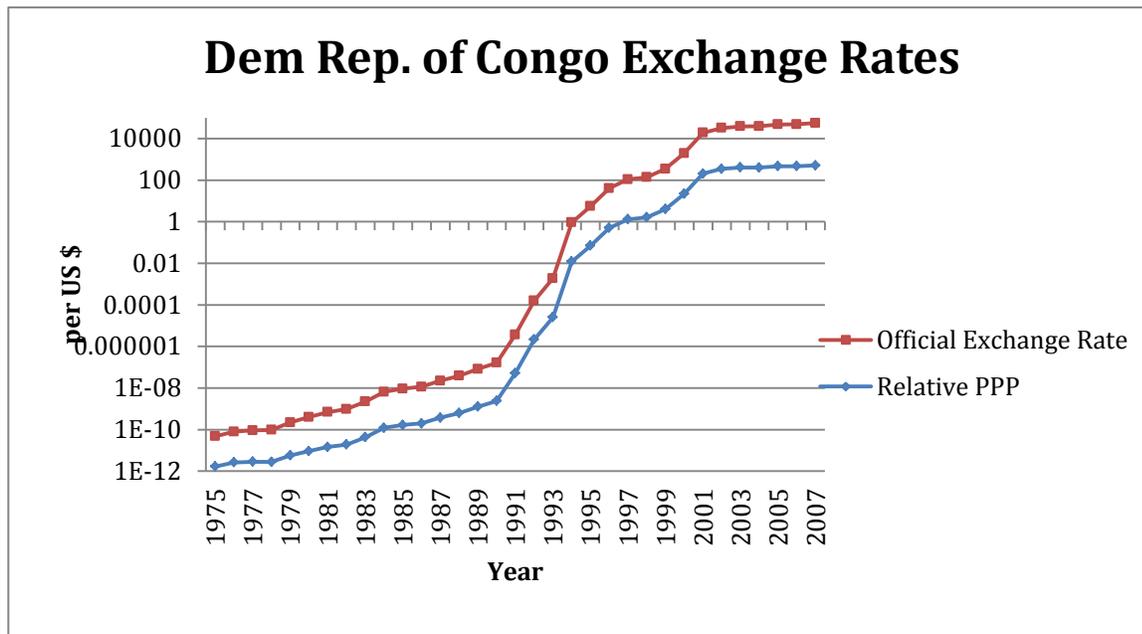
this they would see adjustments in the exchange rates to account for these price changes. The graph shows that the official market exchange rate moves in unison with the relative PPP exchange rate. Thus, we can conclude that the relative exchange rate, while taking into account price level changes, is reflection of what market rates are doing. The difference between the two rates, market and PPP, is explained in greater detail later.

Figure 3.



(World Databank, 2011)

Figure 4.



(World Databank, 2011)

Relative PPP does not account for everything. Most economists agree that in the short-run time horizon, PPP exhibits a price deviation across a significant range of individual goods (Rogoff, 1996). However, it appears that in the long-run time horizon it is some variant of PPP that must explain exchange rates. What we are saying here is that in the long run it appears that there is a slow trend of real market exchange rates (those adjusted for differences in national prices and inflation) to converge to PPP theory; however, in the short run we see extremely volatile fluctuations in the real exchange rate causing it to vary at times significantly from the PPP theoretical rate (Rogoff, 1996). What I am explaining here is the “Purchasing Power Parity Puzzle” as named by Ken Rogoff from Princeton University in his 1996 piece in the *Journal of Economic Literature*.

As suggested, this deviation from theoretical PPP, as we derived earlier, and the actual market rate is the issue we are focusing on. First, let us run through two examples that will illustrate this shortfall in PPP exchange rate calculations. First, we will examine the concept of

over-and undervaluation of currency with particular focus on our three currencies the euro, pound sterling, and US dollar. Secondly, we will explore the Big Mac index as a widely used tool in evaluating PPP in relation to market exchange rates.

Coca-Cola is a good that can be recognized almost immediately in nearly every corner of the world. With dozens of flavors and presence in over 200 countries around the world, a bottle of coke is a great good to examine PPP (Coca-Cola Company, 2010). Before even looking into the PPP or market exchange rates intuition can tell us what we should expect. Having experienced Coke in roughly 6 different countries, I can confidently say the taste varies very little. With the exception of the fountain beverage versus the canned or bottled beverage, Coca-Cola is the same product and tastes the same in Ireland, Italy, Switzerland, Mexico, England and the United States. So relying on intuition, a can of coke should cost roughly the same in the U.S. as it does in the United Kingdom. However, as you will see shortly this is not the case. A can of Coke in New York costs roughly \$1.25. In Ireland you can purchase 2 cans of coke for 2€, making a can of coke cost roughly 1€ in Dublin, Ireland (Euro General, 2007). Absolute PPP would lead us to believe that the exchange rate between Euros and dollars would be as follows:

$$1\text{€}/\$1.25 = .80\text{€}/\$$$

(Gattis, 2010)

But the actual market exchange rate is .71€/€ (Yahoo Finance, 2011). The first theoretical PPP equation shows that it cost .8€ to purchase \$1.00. Said differently, a good that costs \$1.00 in the United States should cost .80€ in the European Union. However, the real market exchange rate as of March 13, 2011 states the USDEUR exchange rate is equal to .71€/€. That means that it would cost .71€ to purchase \$1.00, or a good that costs \$1.00 in the US would cost .7€ in the European Union. This sounds like a great deal for the euro denominated nations, and it opens

the door for arbitrage. The difference between the market exchange rate and the theoretical PPP exchange rate represent the overvaluing of the Euro (Gattis, 2010b). In this case, the euro is valued too high and needs to depreciate to get back to the theoretical PPP where an identical good costs the same in two different countries. In terms of the US dollar, which in this case is undervalued, it would need to appreciate. Arbitrage, which we will delve deeper into shortly, works to converge the theoretical and real market exchange rate and eliminate the over and undervaluation of currencies.

Economists and financiers use the Big Mac index to study international price comparisons and PPP versus real market exchange rates (Gattis, 2010b). Similar to the bottle of Coke example is the idea of the Big Mac and its presence worldwide. Since the Big Mac and many of its ingredients are so highly traded and the pricing data is so readily available, the Big Mac index was created by *The Economist* in 1986 as a way of investigating PPP and price fluctuation around the world (Rogoff, 1996). The Big Mac index shows the pricing disparities for the same good in different countries. As mentioned before volatility in real exchange rates causes an often striking difference between theoretical PPP exchange rates and real market exchange rates (Rogoff, 1996). In the Big Mac index, the prices reflect these differences, or the prices are not what we would derive using a theoretical PPP thus the law of one price is being violated. Rogoff states that goods that exhibit the PPP perfectly are an exception to the rule while goods such as Big Macs showing the differences are the norm. He continues on to mention that gold is one of the commodities that acts as an exception and proves the PPP to be accurate and the real market exchange rate to converge with the PPP exchange rate. Table 4 shows the data as of 1995.

Table 4. THE LAW OF ONE PRICE FOR GOLD

Country	Dollar Price of One Troy Ounce
Hong Kong (late)	379.35
London (late)	379.25
Zurich (late afternoon)	379.10
New York	379.10
Paris (Afternoon)	378.81
Frankfurt (fixing)	378.87

Source: The New York Times, Feb. 24, 1995
(Rogoff, 1996)

As seen in the above table, the price of gold in US dollars is quite constant around the world in the 1995 data. This will make it more apparent how volatile the price differences are in the Big Mac index. It is important, however, to consider the conditions that could account for the differences in prices such as availability of ingredients, additional costs for condiments, or bundling such as value meals (Rogoff, 1996). Nonetheless, the Big Mac index has been used heavily to show the divergence of real market exchange rates and PPP theoretical exchange rates for years. The Big Mac index data is more recent; however, it was similar in 1995 according to the data presented by Rogoff. Take notice in the third column that highlights the over and under valuation of the currency in question. At this point, it should be clear that there is a striking difference between what theoretical PPP tells us exchange rates should be and what market rates actually are.

Table 3.

The hamburger standard					
	Big Mac prices		Implied PPP* of the dollar	Actual dollar exchange rate 23/04/02	Under(-)/over(+) valuation against the dollar, %
	in local currency	in dollars			
United States [†]	\$2.49	2.49	-	-	-
Argentina	Peso 2.50	0.78	1.00	3.13	-68
Australia	A\$3.00	1.62	1.20	1.86	-35
Brazil	Real 3.60	1.55	1.45	2.34	-38
Britain	£1.99	2.88	1.25 [‡]	1.45 [‡]	+16
Canada	C\$3.33	2.12	1.34	1.57	-15
Chile	Peso 1,400	2.16	562	655	-14
China	Yuan 10.50	1.27	4.22	8.28	-49
Czech Rep	Koruna 56.28	1.66	22.6	34.0	-33
Denmark	DKr24.75	2.96	9.94	8.38	+19
Euro area	€2.67	2.37	0.93 [§]	0.89 [§]	-5
Hong Kong	HK\$11.20	1.40	4.50	7.80	-42
Hungary	Forint 459	1.69	184	272	-32
Indonesia	Rupiah 16,000	1.71	6,426	9,430	-32
Israel	Shekel 12.00	2.51	4.82	4.79	+1
Japan	¥262	2.01	105	130	-19
Malaysia	M\$5.04	1.33	2.02	3.8	-47
Mexico	Peso 21.90	2.37	8.80	9.28	-5
New Zealand	NZ\$3.95	1.77	1.59	2.24	-29
Peru	New Sol 8.50	2.48	3.41	3.43	-1
Philippines	Peso 65.00	1.28	26.1	51.0	-49
Poland	Zloty 5.90	1.46	2.37	4.04	-41
Russia	Rouble 39.00	1.25	15.7	31.2	-50
Singapore	S\$3.30	1.81	1.33	1.82	-27
South Africa	Rand 9.70	0.87	3.90	10.9	-64
South Korea	Won 3,100	2.36	1,245	1,304	-5
Sweden	SKr26.00	2.52	10.4	10.3	+1
Switzerland	SFr6.30	3.81	2.53	1.66	+53
Taiwan	NT\$70.00	2.01	28.1	34.8	-19
Thailand	Baht 55.00	1.27	22.1	43.3	-49
Turkey	Lira 4,000,000	3.06	1,606,426	1,324,500	+21
Venezuela	Bolivar 2,500	2.92	1,004	857	+17

Sources: McDonald's; *The Economist*

*Purchasing-power parity: local price divided by price in United States
[†]Average of New York, Chicago, San Francisco and Atlanta
[‡]Dollars per pound [§]Dollars per euro

(Gattis, 2010b)

Now that the foundation of PPP, its theory and application have been laid out, we can begin exploring the use of PPP to answer the question of why purchasing power varies so much among the currencies we have chosen to examine. It seems from the theory and mathematical formulas that PPP should allow for a very even foreign exchange market where goods and

services costs are equivalent in other countries with no opportunities for arbitrage. However, as seen in the brief outline of the currency market, this is not the case. With the knowledge of both the foreign exchange market and the foundation of PPP, let us investigate why the goods we buy in America do not cost the same in England, or better said, why does our purchasing power change?

Section F: The Law of One Price Revisited

Throughout this investigation of purchasing power parity we have been nibbling at the edges of this notion of the law of one price. Revisiting the definition of the law of one price, Alan and Mark Taylor eloquently define the law of one price as follows, “The Law of One Price holds that the price of an internationally traded good should be the same anywhere in the world once that price is expressed in a common currency. Law of One Price implies that a PPP exchange rate should hold between the countries concerned” (Taylor and Taylor, 2004). What I have outlined throughout the paper is the apparent violations of the law of one price. It has become quite obvious that an internationally traded good does not hold the same price in different nations. So what is the reason for the differing prices and absence of the law of one price? The answer to that question is both lengthy and incomplete. It also remains unanswered. However, one direction to explore is the concept of arbitrage, or in this case the lack thereof.

Section G: Arbitrage

Section one explores the concept of arbitrage, noting the most common forms of arbitrage in the forex market. Arbitrage shares a unique relationship with the law of one price and the notion of theoretical PPP. Intuitively, one should come to the conclusion that if there are price differences in alternate locations then one would buy low and then sell high. This is, of course, what arbitrage is at its most elementary level. In the realm of tradeable goods, if there are areas

where the good is priced lower and areas where the same good is priced higher, then why not buy at the low price and sell at the high price? This does exist and when it happens we see prices converge. Stepping away from forex for a moment, let us examine a common example. Say you are a regular consumer of Cheerios. If Cheerios are priced at \$3.00 per box in location A and \$4.50 in location B, you have in front of you an arbitrage opportunity. You would then purchase Cheerios in location A for \$3.00 and sell the Cheerios in Location B for \$4.25 and make a profit of \$1.25. At this level it seems insignificant but say you were to buy 10,000 boxes of Cheerios. Your profit just became \$12,500. Arbitrage is everywhere, but typically it does not last. Prices converge and reach an equilibrium across the board. This is true in foreign exchange as well; arbitrage opportunities are exhausted until the theoretical PPP exchange rate and market exchange rate converge and satisfy the law of one price (Taylor and Taylor, 2004). So what might account for this lack of arbitrage and the differing exchange rates? Once again that answer highly debated, but let us examine a few options.

Transactions costs, the cost of participating in the market, are just one piece of the puzzle in explaining the lack of price convergence due to insufficient arbitrage (Rogoff, 1996). Transaction costs in their relation to tradeable goods can be considered things such as transportation costs, insurance costs or buyer-seller commissions, among many more (Rogoff, 1996). Any additional cost associated with international trade puts up a barrier that could be high enough to prevent arbitrage from happening (Rogoff, 1996). In addition to transaction costs are often times significant labor costs associated with tradeable goods.

A second barrier to arbitrage is information costs. There is a severe lack of regulation and transparency in the foreign exchange market. This information asymmetry feeds into prohibiting arbitrage opportunities because they become unrecognizable. The lack of regulation in the forex

market creates countless opportunities for hidden information, adverse selection, and hidden action, moral hazard. With these issues largely present in the market arbitrage remains limited.

Tariff and non-tariff barriers to trade inhibit price convergence and arbitrage opportunities (Rogoff,1996). Tariffs, although steadily decreasing over the past several decades, act as a trade barrier and therefore limit the amount of arbitrage that can be conducted (Rogoff, 1996). With tariffs in place, what was once an opportunity for arbitrage now becomes subject to increasing price divergence and heightened volatility of market exchange rates (Rogoff, 1996). Non-tariff barriers to trade are also to blame. Non-tariff barriers could include higher prices charged to overcome other transaction costs, stringent and costly inspections of traded goods, and quality standards that are difficult to be met by the exporting or importing party (Rogoff,1996). All of these add additional costs and higher barriers to tradeable goods significantly decreasing opportunities to act upon arbitrage.

Finally, arbitrage limitations are found in certain industries because some goods are near impossible to trade and therefore the prices are not likely to converge to the law of one price via ordinary means (Rogoff, 1996).

Lack of arbitrage as an explanation for the violation of the law of one price is merely one small contributing factor. There are countless reasons that the law of one price is not readily observed in the short-run regarding PPP exchange rates and real market exchange rates. Various economists have explored this issue in detail. Some have come to similar conclusions about the lack of arbitrage while others have done a deeper investigation finding the differences in exchange rates to be the result of a host of problems. A lack of arbitrage due to the reasons briefly examined above explains just one avenue of why the exchange rates vary. I would like to briefly mention one other reason that was addressed in various research materials.

The concept is value added tax, VAT. European countries have a value added tax similar to the United States sales tax in that is levied on purchases and collected by the government. The relation here is that the VAT is added into the price, not added on at the point of sale as done in the United States, is higher in countries using a VAT rather than adding the tax on at the end (Bank of England, 2010). An example to clarify: the price of pack of pens in the United States is \$5.00, but when making the purchase at the register with a 6.25% sales tax, then the total becomes \$5.31. However, in a country with a VAT the price tag would say 6€ and at the register the customer would pay 6€ and nothing extra because the tax is part of the price. The effect here is that the prices used to calculate the PPP exchange rates could be skewed because of the different tax structures in place in the different countries.

Conclusion

Posed with the question why do we pay different prices for the same good in two different countries this thesis has led to several conclusions. With the examination of the market exchange rate and the theoretical PPP exchange rate, it has become apparent that there is a striking difference between what the market sets for the exchange rate and what a comparison of two prices would yield for an exchange rate, PPP exchange rate. This difference in the two rates shows a clear violation of the law of one price. It turns out that the question being asked all along was why is the law of one price being violated? The comparison of the two exchange rates, market and PPP, shed light on this issue and led to the conclusion found here. A lack of arbitrage is accounts for a portion of this difference in rates and a violation of the law of one price. The lack of arbitrage can be explained in several ways. Here, the conclusion is high transaction costs, information costs, tariff and non-tariff barriers to trade and the impossibility of trade for some goods. The final conclusion is that if more arbitrage opportunities are taken

advantage of, the exchange rates will begin to converge and the law of one price will be seen in more in the short run rather than exclusively in the long run. This is only one piece of the purchasing power parity puzzle, and economists will continue to investigate this issue until a solution or explanation is reached.

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Academic Vita

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Education

The Pennsylvania State University, Smeal College of Business

University Park, PA

Schreyer Honors College

Bachelor of Science: Finance

Expected Graduation: May 2011

Bachelor of Arts: Economics

The Institute at Palazzo Rucellai

Florence, Italy

Professional Experience

Comcast Capital Corporation

Wilmington, DE

Treasury Services Intern

May 2010- July 2010

- Transformed raw data of over eight hundred NBCU bank accounts into a cash flow schema that will act as the framework for managing NBCU funds following the 2010 merger of Comcast and NBCU
- Completed monthly account analysis for seven hundred Comcast bank accounts and monthly investment reports
- Restructured quarterly liquidity report for optimum informational value that was distributed to company executives

Pepper's Fine Foods Catering

Northborough, MA

Executive Assistant

July 2004 – August 2008

- In charge of contacting and meeting with prospective and confirmed clients to finalize plans for their events
- Delegated work assignments to two interns, staff on events, and twenty employees in the office
- Worked on projects involving event planning for events with up to nine hundred guests

Assistant in Accounting Department

June 2007 - August 2007

- Responsible for imputing bills into quick books, filing, and payroll for two hundred employees
- Worked on project for calculating profit from contract with local golf course

Smeal College of Business Undergraduate Programs

University Park, PA

- Employed as an office assistant making appointments for students and their advisors September 2007- present
 - Maintain the front desk assisting and greeting everyone entering the office
-

Activities and Community Service

Smeal College of Business Roundtable

President

January 2010-present

- Oversee forty Smeal Organizations and their leaders, as well as manage budget allocation for Smeal Organizations
- Conduct biweekly meetings with the executive board members of Smeal Organizations, facilitate open forum during meetings; as president of BRT I hold a position on the Smeal Alumni Advisory Board

Smeal Student Society

President

January 2009-December 2009

- Spokesperson for the organization; maintain communication with the organizations sixty five active members, advisor, and executive board; assist the board in all aspects and provide final say in decision making
- Oversee two thousand dollar budget, arrange tours for all visitors, and act as liaison between Smeal community and organization

General Member & Leader of Community Service Committee

September 2007- present

- Responsible for giving tours to prospective students, alumni, and corporate visitors of the 210,000 square foot business building at Penn State University

Phi Eta Sigma National Honors Society

Penn State Panhellenic/IFC Dance Marathon Chair

September 2009-present