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Systems Engineering Approach To Solve Drug Violence Problem

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SYSTEMS ENGINEERING APPROACH TO SOLVE DRUG VIOLENCE
PROBLEM

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Master's Program in Systems Engineering

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2016

SYSTEMS ENGINEERING APPROACH TO SOLVE DRUG VIOLENCE
PROBLEM

by

JAGADISH THIMIRI MALLIKARJAN, B.E.

THESIS

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The University of Texas at El Paso
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Table of Contents

Acknowledgments.....	iv
Table of Contents.....	v
List of Figures.....	vi
Chapter 1: Systems Engineering	1
Chapter 2: System Dynamics.....	3
Chapter 3: Problem Statement.....	5
Chapter 4: Basics of Supply and Demand.....	11
Chapter 5: Analysis of Drug Trade	24
Chapter 6: Conclusion.....	31
Appendix.....	32
References.....	34
Vita.....	36

List of Figures

Figure 1: Systems Engineering practiced across different domains.....	2
Figure 2: System Dynamics Example.....	3
Figure 3: Cartel Illicit Activities.....	6
Figure 4: Illegal Immigration and Cartels.....	7
Figure 5: Systemic Enablers of Cartels in Mexico.....	8
Figure 6: Interdiction is a failure.....	9
Figure 7: Long term solution vs short term solution.....	10
Figure 8: Demand Curve showing Demand Relationship.....	12
Figure 9: Supply Curve showing Supply Relationship.....	13
Figure 10: Supply and Demand in Equilibrium.....	14
Figure 11: Excess Supply.....	15
Figure 12: Excess Demand.....	16
Figure 13: Elastic Demand.....	17
Figure 14: Inelastic Demand.....	18
Figure 15: Elastic Supply.....	19
Figure 16: Inelastic Supply.....	20
Figure 17: Producer and Consumer Surplus	21
Figure 18: Deadweight Loss.....	22
Figure 19: Producers gain by interdiction	23
Figure 20: Value of Drug in the supply before and after interdiction.....	26

Figure 21: Positive feedback.....27

Chapter 1

1.1 Systems Engineering

“Systems engineering constitutes an interdisciplinary approach, and a means to enable the realization of a successful system by an orderly process” [Blanchard Benjamin S, 2008, p.1].

1.2 Why Systems Engineering?

The view of system engineering is to break a complex system into a simple system, i.e. decomposing a complex problem into a simple problem which is solvable without leaving out any entities, taking into account of synthesis and emergence.

1.3 Systems Engineering Across Domains

According to SE Vision 2025, “Systems engineering is being adapted to support many application domains in both common and industry-unique ways. Embracing the diversity of practice while leveraging practices that deal with common system challenges enriches the discipline” [INCOSE SE Vision 2025, 2014, p. 17].

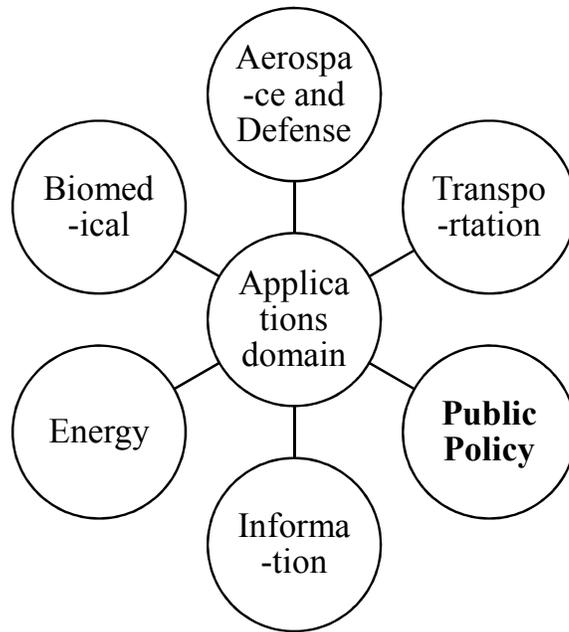


Figure 1: Systems Engineering practiced across different domains
[Based on INCOSE SE Vision 2025, 2014, p.17]

From Figure 1, we can see that systems engineering can be applied to the domain of Public Policy by implementing one of the techniques in systems engineering, System Dynamics. System Dynamics is used to analyze the current problem situation and come up with a solution to have an influence on policy makers to create public policy.

Chapter 2

2.1 System Dynamics

System Dynamics is a powerful computer-aided approach for framing, understanding complex problems, policy analysis and the design of any dynamic system characterized by interdependence, mutual interaction, information feedback, and circular causality.

System Dynamics is approached by defining the problem dynamically. Modeling begins by mapping the nodes and arcs which is illustrated in the figure below.

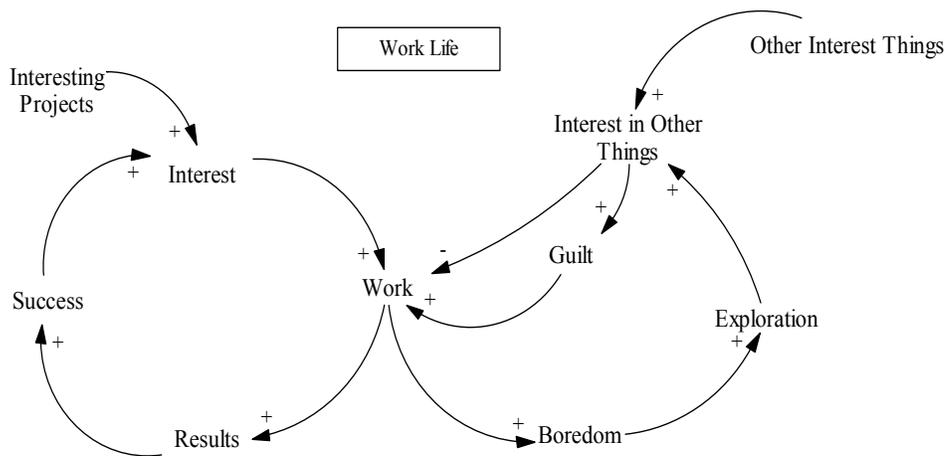


Figure 2: System Dynamics Example (www.advancedepidemiology.org)

Figure 2 demonstrates the positive feedback to the work life created by the expansion of other activities. The activities in the work domain are interlinked in such a way that each activity supplies the other activities with resources for their

operation. For example, Interest leads to increase in work, which in turn leads to increase in results, which leads to success and from work which leads to increase in boredom, which leads to increase in exploration, which in turn leads to interest in other things, which in turn increases guilt and leads to increase in work. Also interest in other things leads to negative feedback in work.

System Dynamics is used to gain an integrated view of the major forces that can affect key outcomes over great stretches of time in the future. An integrated, strategic view is necessary when various variables have multiple consequences depending on the application.

System dynamics can be applied to complex social, managerial, economic systems.

2.2 Feedback Thinking

The feedback concept is at the conceptual heart of the system dynamics approach. Information feedback loops and circular causality diagrams are used to conceptualize the structure of a complex system and communicate model-based insights.

The system dynamics approach to model interconnected system parts strives to demonstrate the behavior of a system as a consequence of the system's structure.

Chapter 3

3.1 Problem Statement

The War on Drugs has caused cartel-related violence to increase, creating a challenge for socio-political stability in Mexico. Currently, the U.S. government focuses on law enforcement measures to interdict drugs in the cartel supply lines. According to the GAO report, in the year 2010, approximately \$18 to \$39 billion dollars of drug sale dollars are smuggled into Mexico each year [GAO-11-73].

Cartel operations have expanded into human trafficking, weapons smuggling, kidnapping, and extortion.

The cartel problem is approached in this thesis from a systems thinking perspective, a holistic assessment by identifying different domains of cartel operation. The domains can be separated, and each domain is examined to identify the relationship and the casual factors contributing to the problem situation.

The domains identified are cartel domain, economic domain, Systemic Enablers

Cartel Domain:

The activities of the cartel domain are identified. The activities of the cartel domain are drug trafficking, drug profits, contraband revenues, arms purchases, arms smuggling, cash smuggling, kidnapping, extortion and human smuggling.

These activities are shown in Figure 3 below.

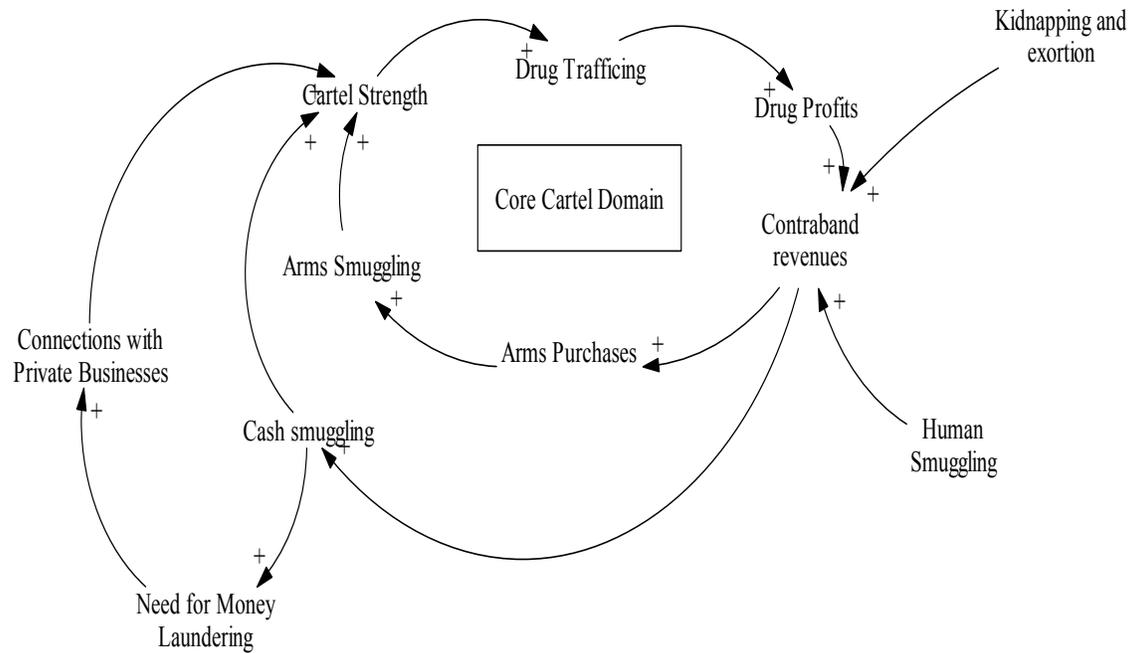


Figure 3: Illicit Cartel Activities
 [Mcgee, Joel, Edson, Mexico's Cartel Problem: A Systems Thinking Perspective, p .4]

Figure 3 demonstrates the positive feedback to cartel profits created by the expansion of criminal activities. The activities in the cartel domain are interlinked in such a way that each activity supplies the other activities with resources for their operation, and which in turn makes the cartel a powerful and complex enterprise. For example, drug trafficking leads to increases in drug profits, which in turn leads to increases in contraband revenue, which leads to arms purchases, and which in turn leads to arms smuggling. Also, cash smuggling leads to money laundering, which in turn leads to an increase in cartel strength.

through human trafficking activities. The poor socio-economic conditions in Mexico, leads to high illegal immigration and human trafficking from Mexico to the USA.

Systemic Enablers:

The systemic enablers for the cartel domain are the failure to penalize, failure to prosecute, failure to arrest, and prison escapes. Cartels bribe public officials and government personnel, leading to corruption of prison officials, corruption of crime prosecutors, corruption of police, corruption of military officers, corruption of public officials, and to the corruption of customs and border agencies, which leads to the failure of drug interdiction.

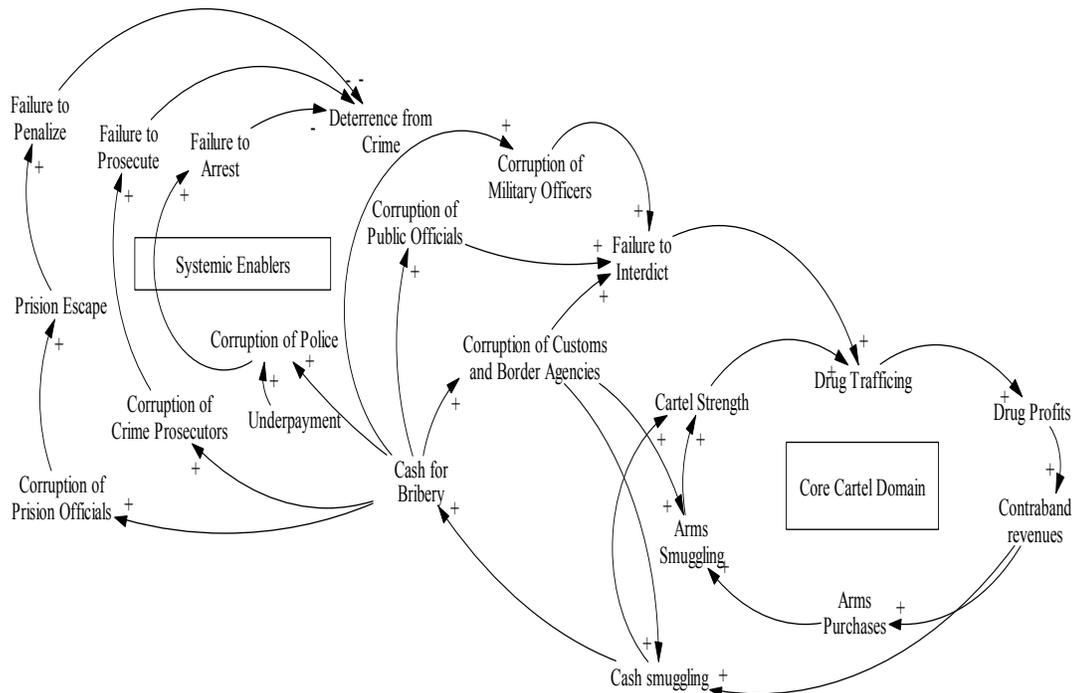


Figure 5: Systemic Enablers of Cartels
 [Mcgee, Joel, Edson, Mexico’s Cartel Problem: A Systems Thinking Perspective, p .5]

From Figure 5, it can be seen that Corruption plays an important role in cartel activities. Because cartels are powerful and wealthy enterprises, cartels can bribe military officers, public officials and customs and border agencies, which allows the cartels to function without any problem, and which in turn strengthens the cartel domain.

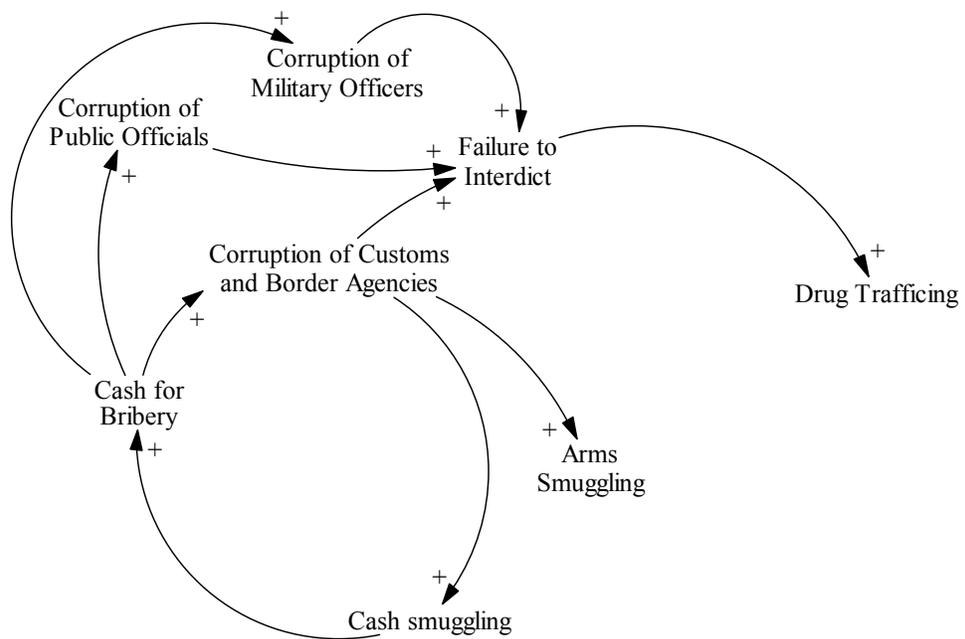


Figure 6: Interdiction is a failure
 [Mcgee, Joel, Edson, Mexico's Cartel Problem: A Systems Thinking Perspective, p .5]

From Figure 6, it is clear that the cartels pose a significant challenge to the national security of the US. The current efforts, which rely purely on law enforcement activities such as interdiction, are failing to produce the desired results expected by the government, namely, to the prevent consumption and trading of illegal drugs.

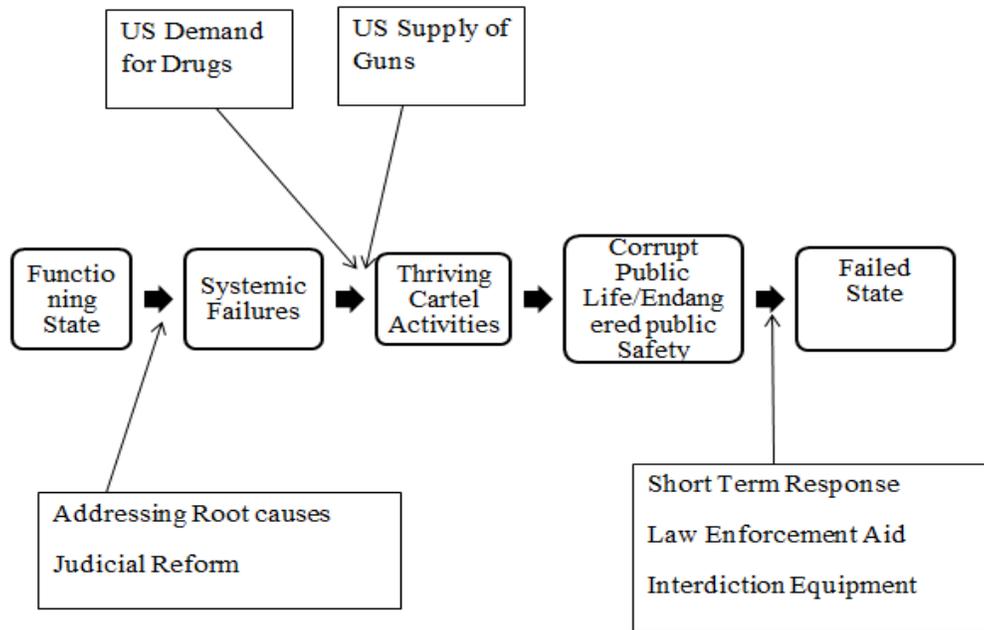


Figure 7: Long-term Solution Vs Short-term Solution
 [Mcgee, Joel, Edson, Mexico's Cartel Problem: A Systems Thinking Perspective, p .8]

Figure 7 demonstrates the current situation and from the figure, it shows that the current system functions as failed state because the government is focusing on the short term solution (interdiction) and the not the long-term solution which is to bring a reform in the judicial system.

The System dynamics approach provided a useful analytical framework to understand markets for illegal drugs and deficiencies in the US and Mexico governments. On the conceptual side, while there are many positive (+) signs (worsening the situation among negative factors) in the system dynamics diagrams, the conceptual solution provided in this thesis will lead to negative (-) signs (improvement in the situation) in the system dynamics diagrams.

Chapter 4

4.1 Basics of Supply and Demand

“Supply and Demand is the fundamental concepts of economics and it is the theoretical backbone of a competitive market function.

4.2 Demand Point

Demand refers to the quantity of a product that is desired by buyers, at a given price.

4.3 Supply Point

Supply refers to the quantities of a product that are supplied into the market at different prices.

4.4 Demand Relationship

The correlation between the price and the quantity demanded is known as the demand relationship.

4.5 Supply Relationship

The correlation between price and quantity of goods supplied is known as the supply relationship. The allocation of goods in market is based on the principles of supply and demand.

4.6 Law of Demand

The law of demand states that the higher the price of a good, all other factors remaining equal, the lower the quantity demanded. As a result, people will naturally avoid buying a product at a very high price. The demand curve is a downward slope as shown in Figure 8.

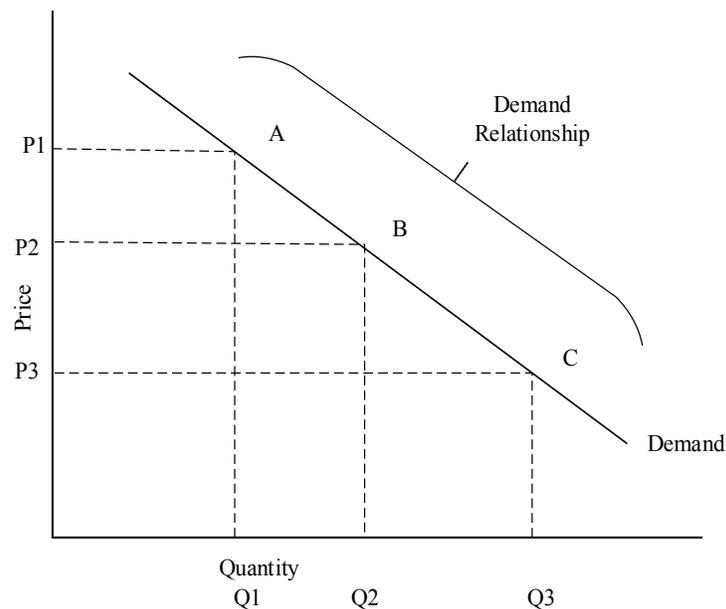


Figure 8: Demand Curve showing Demand Relationship
[Investopedia.com,2003]

In Figure 8, the points on the demand curve show a correlation between quantity demanded and price. $Q1 < Q2 < Q3$ and $P1 > P2 > P3$. At point A, the quantity demanded will be $Q1$ and the price will be $P1$. At point B, the quantity demanded will be $Q2$ and the price will be $P2$. At point C, the quantity demanded will be $Q3$ and the price will be $P3$. Figure 8 shows the negative relationship between price and quantity demanded. The higher the price of

good, the lower the quantity demanded, and the lower the price, the more the goods will be in demand.

4.7 Law of Supply

The law of supply states that the higher the price of a good, the higher the quantity supplied. The supply curve is an upward slope as shown in Figure 9.

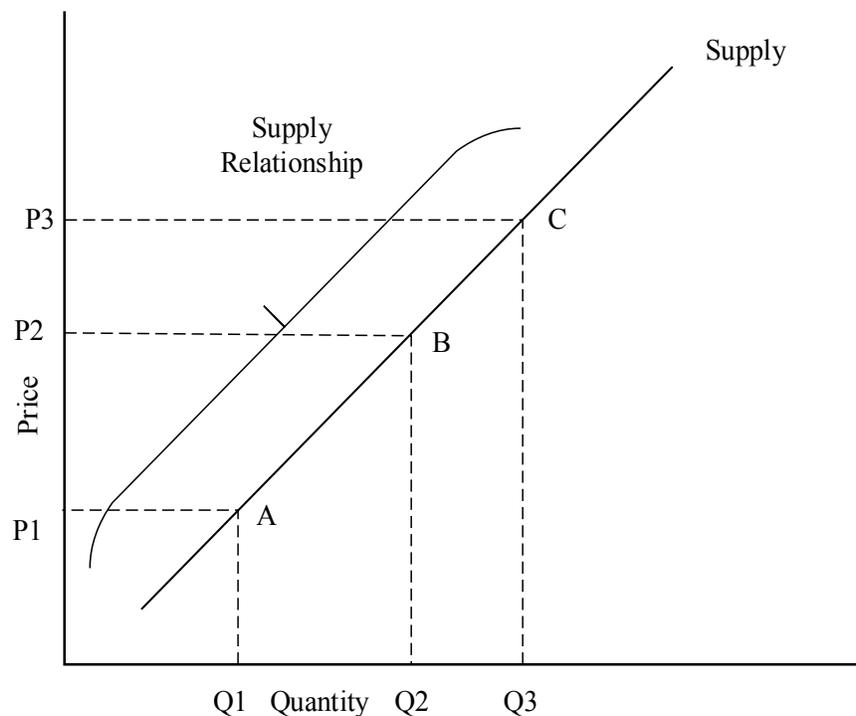


Figure 9: Supply Curve showing Supply Relationship
[Investopedia.com, 2003]

Figure 9, the points on the demand curve show a correlation between quantity supplied and price. $Q1 < Q2 < Q3$ and $P1 > P2 > P3$. At point A, the quantity supplied will be Q1 and the price will be P1. At point B, the quantity supplied

will be Q_2 and the price will be P_2 . At point C, the quantity supplied will be Q_3 and the price will be P_3 . Figure 9 shows the positive relationship between price and quantity demanded. The higher the price of a good, the higher the quantity of goods will be supplied.

4.8 Equilibrium

Supply and demand are at equilibrium where the supply function and demand function intersect. At equilibrium, the allocation of goods is efficient. Because the amount of goods supplied is exactly the same as the amount of goods demanded.

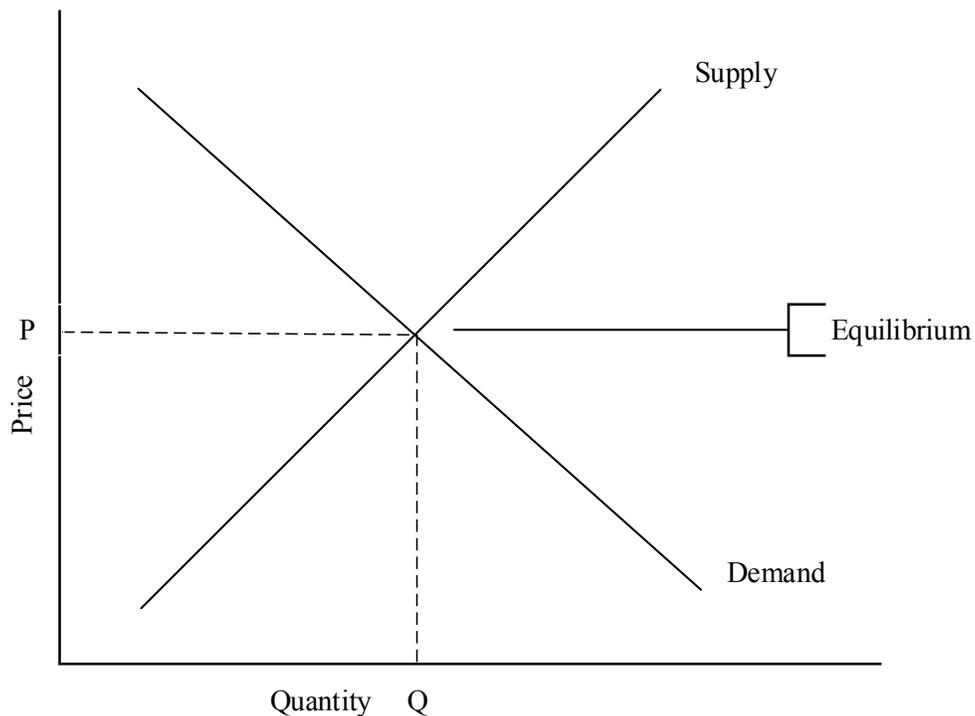


Figure 10: Supply and Demand in Equilibrium
[Investopedia.com, 2003]

As shown in Figure 10, equilibrium occurs at the intersection of the demand and supply curve, which shows allocative efficiency.

4.9 Excess Supply

When the price is set too high, by a government price floor at P_1 , for example, excess supply will be created and there will be allocative inefficiency.

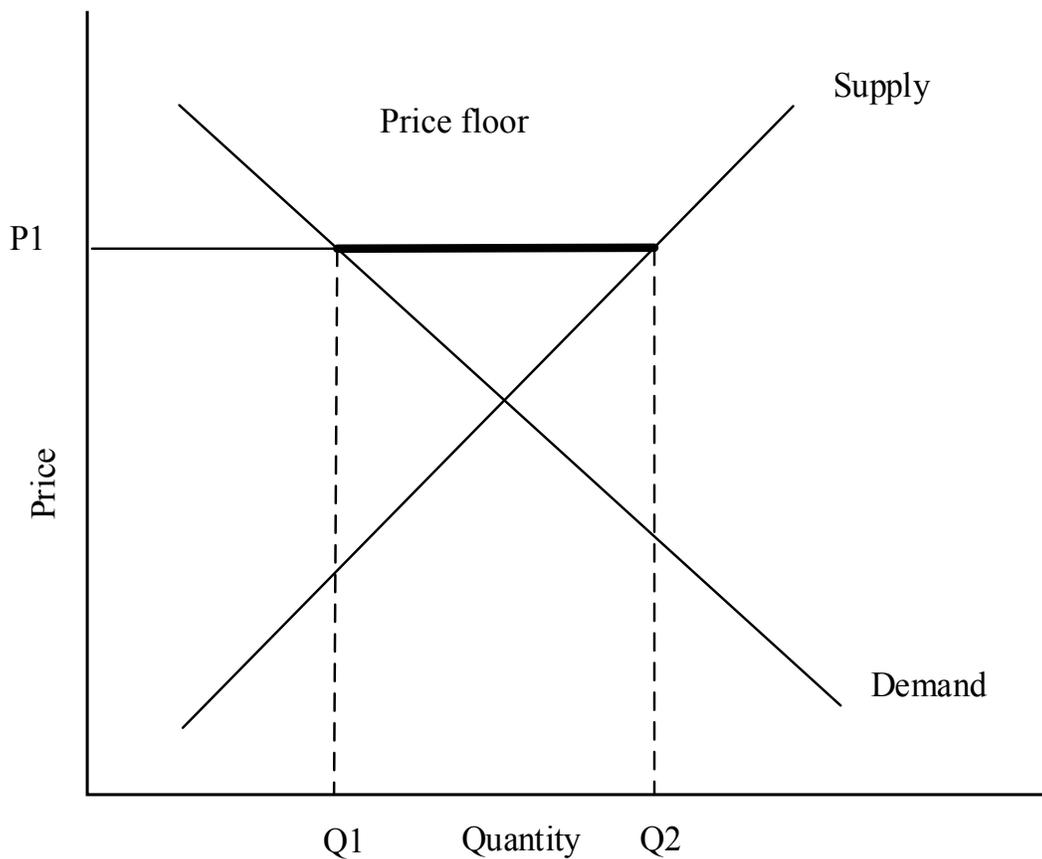


Figure 11: Excess Supply
[Investopedia.com, 2003]

From Figure 11, Q_2 is number of goods supplied by producers at price P_1 while only Q_1 goods were in demand. Since $Q_1 < Q_2$, excess goods are supplied, compare to the goods in demand.

4.10 Excess Demand

When the price is set too low, by a government price ceiling at P_1 , for example, excess demand will be created and there will be allocative inefficiency.

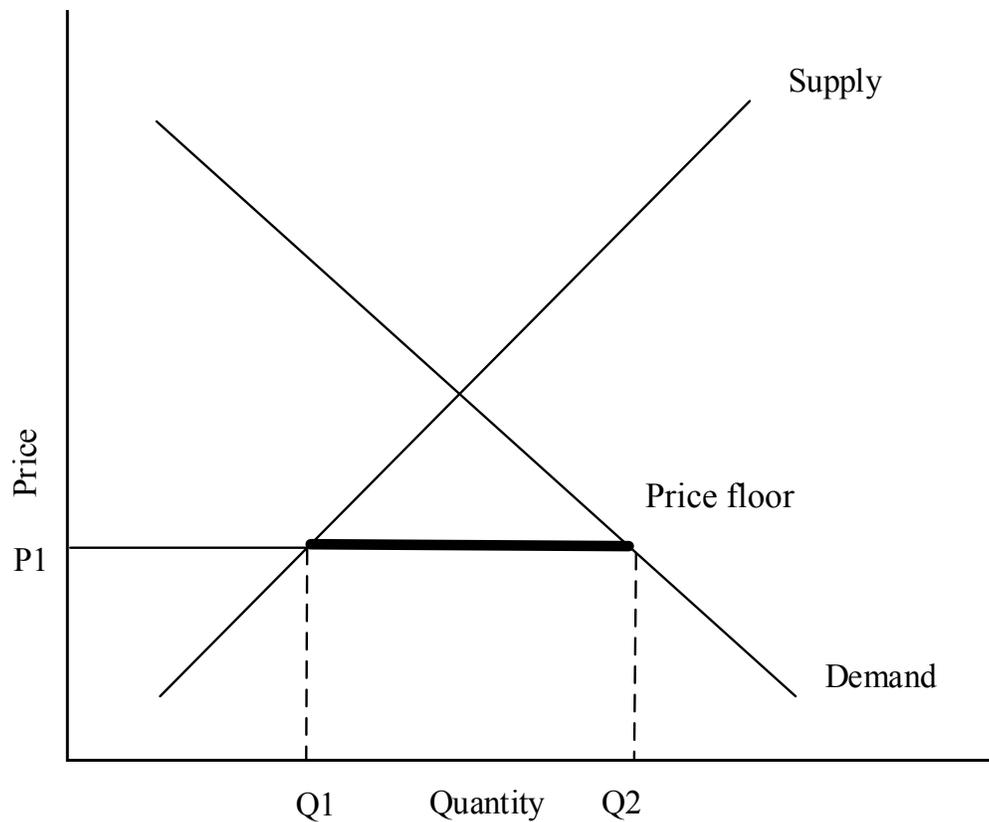


Figure 12: Excess Demand
[Investopedia.com, 2003]

In Figure 12, Q_1 is number of goods supplied by producers at price P_1 and Q_2 goods are in demand. Since $Q_1 < Q_2$, there is a shortage of goods supplied”
[Economics Basics: Supply and Demand: Investopedia. (n.d). Retrieved from <http://www.investopedia.com/university/economics3.asp>].

4.11 Elasticity and Inelasticity:

The degree to which a demand or supply curve reacts to a change in price is the curve's elasticity. Elasticity of the supply or demand curves can be determined using the equation below:

$$\text{Elasticity} = (\% \text{change in quantity} / \% \text{change in price})$$

If elasticity is greater than or equal to one, the curve is considered to be elastic.

If it is less than one, the curve is said to be inelastic.

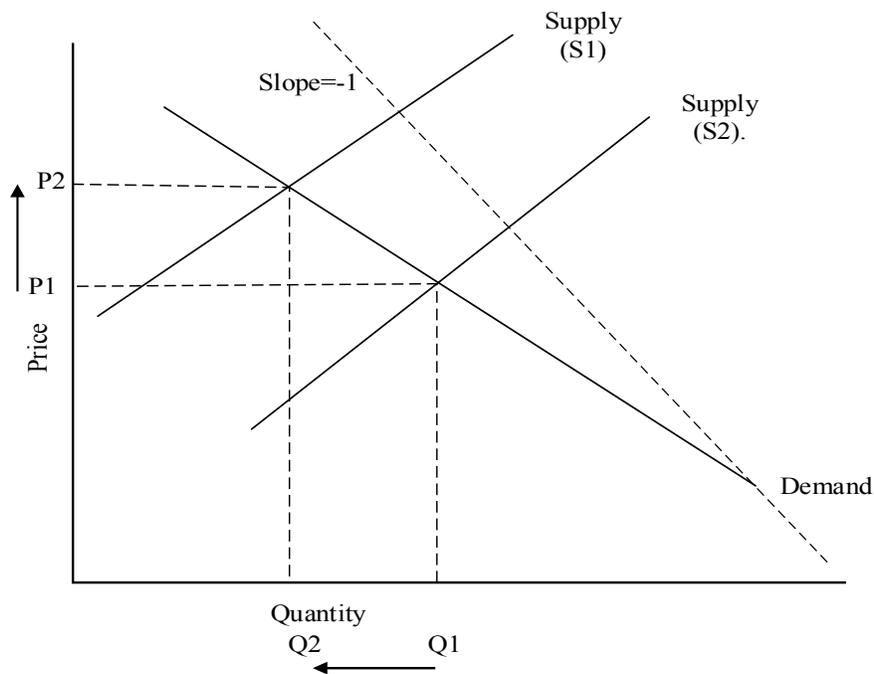


Figure 13: Elastic Demand

The relatively flat curve in Figure 13 shows elasticity of demand.

$$\text{Elasticity} = (\% \text{change in quantity} / \% \text{change in price})$$

$$= ((Q1 - Q2) / Q1) / ((P1 - P2) / P1) \geq 1$$

= One or greater than one is considered elastic demand

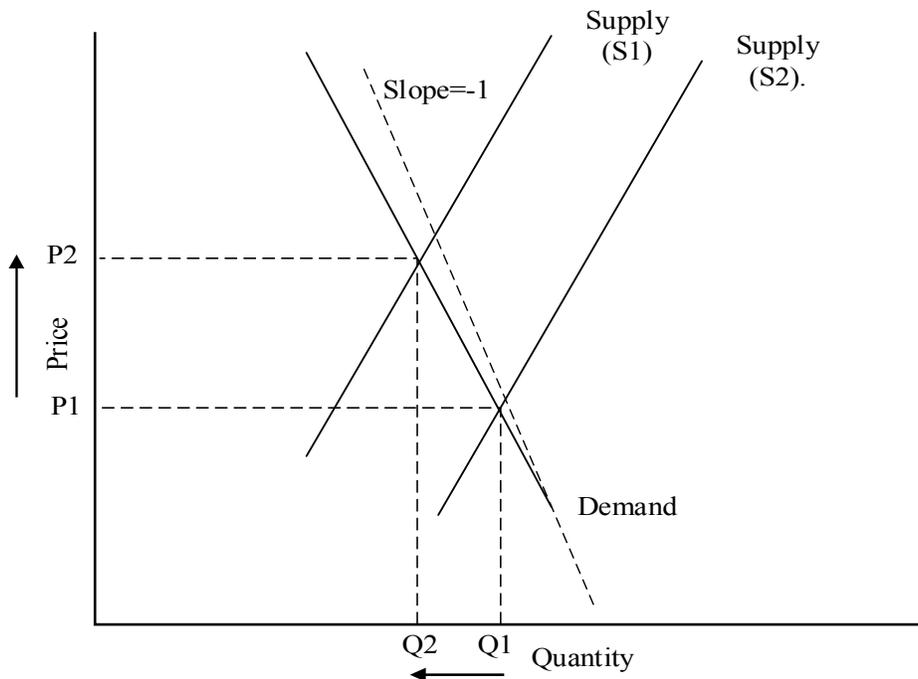


Figure 14: Inelastic Demand

From Figure 14, the relatively upright demand curve illustrates inelastic demand.

$$\text{Inelasticity} = (\% \text{change in quantity} / \% \text{change in price})$$

$$= ((Q1 - Q2) / Q1) / ((P1 - P2) / P1) < 1$$

= less than one is considered inelastic demand

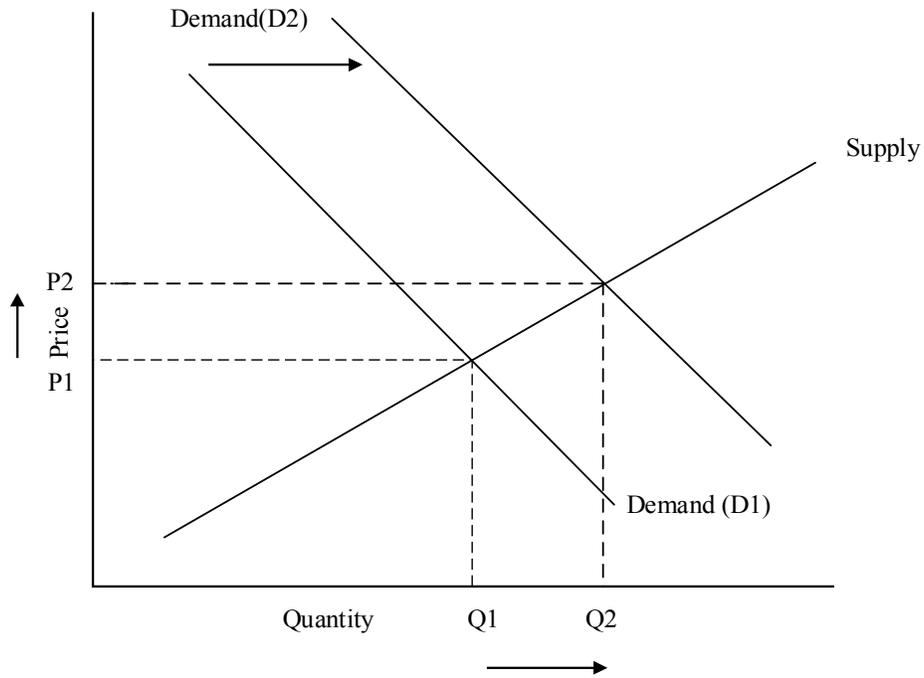


Figure 15: Elastic Supply

From Figure 15, the relatively flat curve means that the good has an elastic supply.

$$\text{Elasticity} = (\% \text{change in quantity} / \% \text{change in price})$$

$$= ((Q2 - Q1) / Q1) / ((P2 - P1) / P1) \geq 1$$

= One or greater than one is considered elastic supply

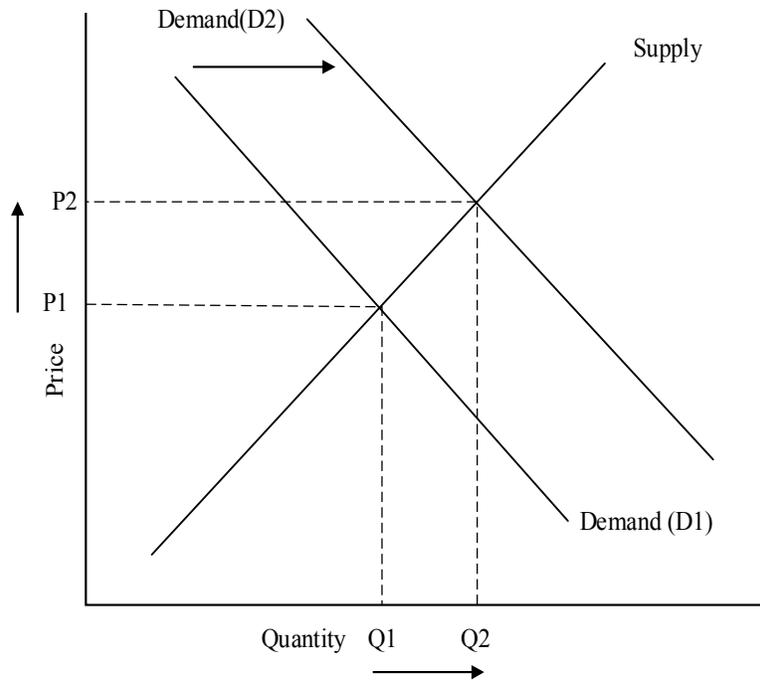


Figure 16: Inelastic Supply

From Figure 16, the upright supply curve is considered inelastic supply.

Elasticity = (%change in quantity/%change in price)

$$= ((Q2-Q1)/Q2) / ((P2-P1)/P2) < 1$$

=less than one is considered inelastic supply.

4.12 Producer Surplus

‘Producer surplus is the firms receive by getting more for their product than the minimum they were willing to accept which is shown in figure 17.

4.13 Consumer Surplus

Consumer surplus is the difference between what consumers are willing to pay relative to market price. If consumer is willing to pay more than the required price of the goods than consumer surplus occurs which is shown in figure 17' [Economic Surplus-Wikipedia, the free encyclopedia. (n.d). Retrieved from https://en.wikipedia.org/wiki/Economic_surplus].

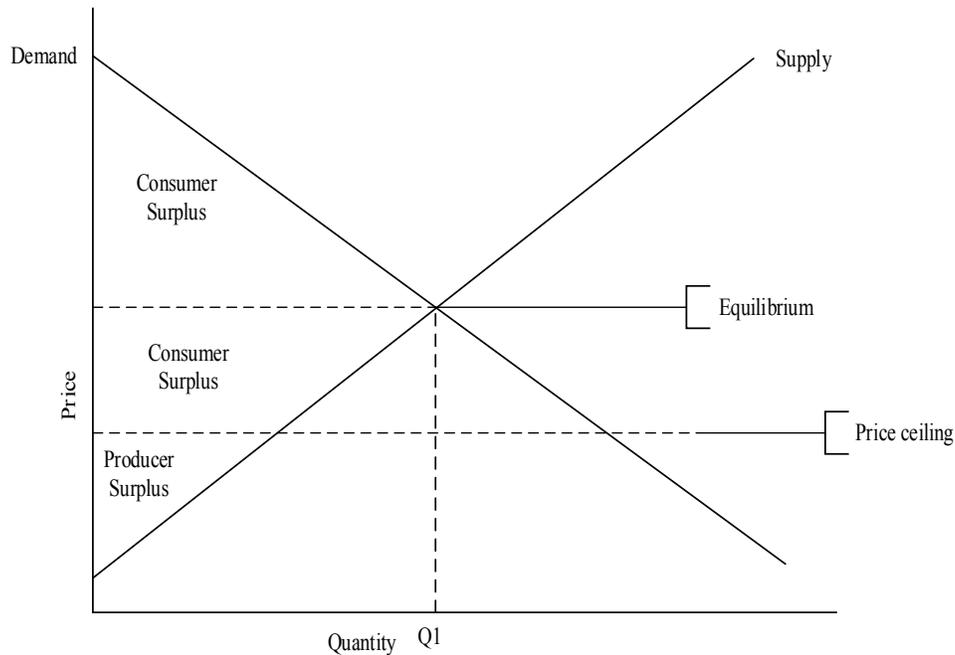


Figure 17: Producer and Consumer Surplus
[Wikipedia.com, 2015]

4.14 Deadweight Loss

“A deadweight loss is a loss of economic efficiency. Deadweight loss can occur when equilibrium for a good or service is not achieved or is not achievable.

Causes of deadweight loss can include monopoly pricing, price ceiling”
 [Deadweight loss-Wikipedia, the free encyclopedia. (n.d). Retrieved from
https://en.wikipedia.org/wiki/Deadweight_loss].

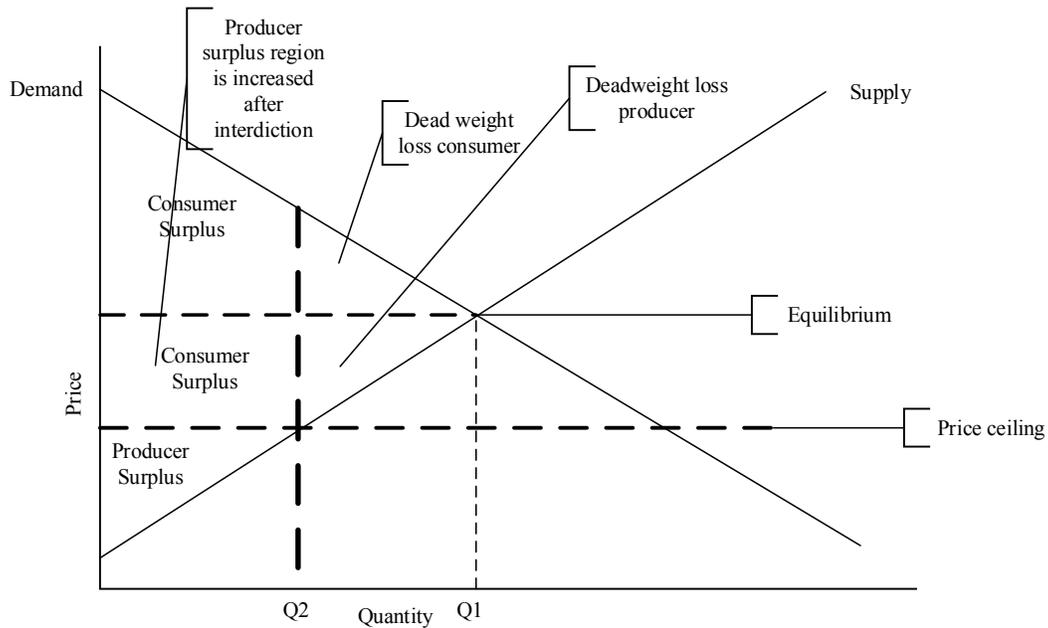


Figure 18: Deadweight Loss [Wikipedia.com,2015]

There is a deadweight loss to drug consumers of approximately 2 billion dollars per year. There is a deadweight loss to the DEA of approximately 10 billion dollars to interdict and incinerate 10 % of the 38 billion dollars in inventory in the supply chain.

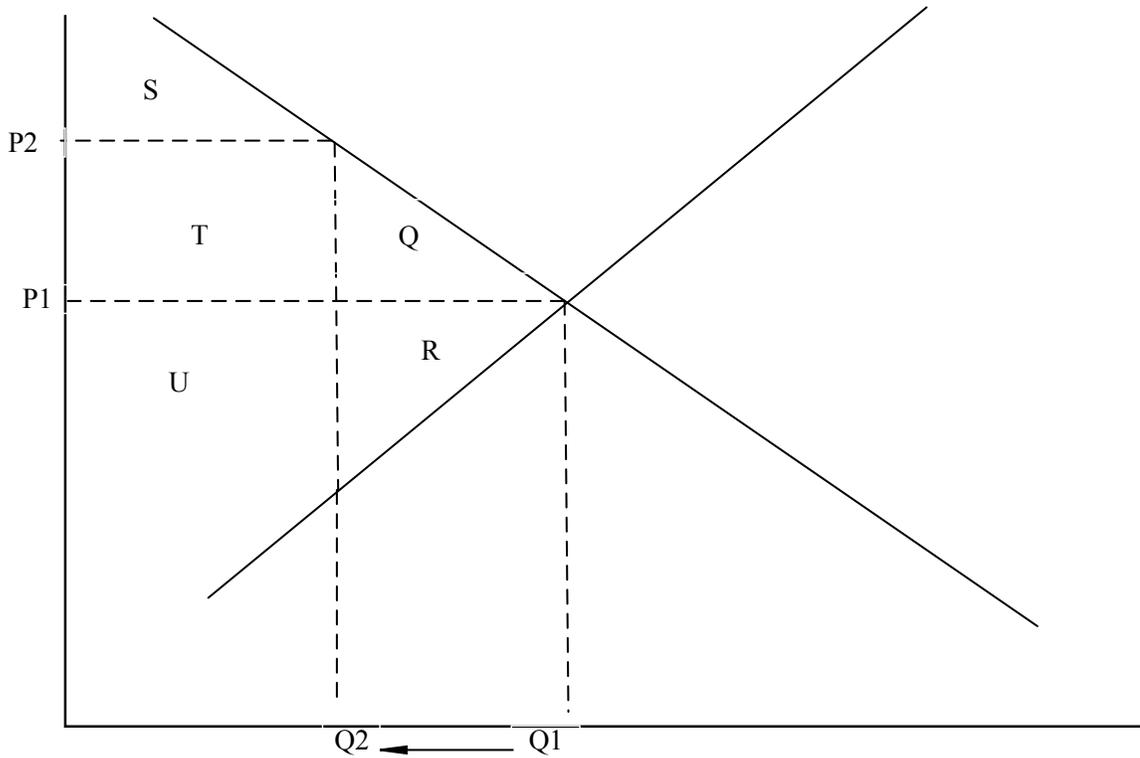


Figure 19: Producers gain by interdiction

Figure 19 demonstrates from the concept of dead weight loss, originally the consumer surplus = $S+T+Q$ and the producer surplus = $U+R$.

After interdiction the consumer surplus = S and producer Surplus = $U+T$.

The net gain after interdiction for producers = $T-R$. This demonstrates that interdiction is beneficial to the drug traffickers.

Chapter 5

5.1 Analysis of Drug Trade

Richard Davidson in his book *The Pursuit of Oblivion*, criticized the efficacy of the War on Drugs by pointing out that, only “10–15% of illicit heroin and 30% of illicit cocaine is intercepted. Drug traffickers have gross profit margins of up to 300%. At least 75% of illicit drug shipments would have to be intercepted before the traffickers' profits were hurt” [War on Drugs-Wikipedia, the free encyclopedia. (n.d). Retrieved from https://en.wikipedia.org/wiki/War_on_Drugs].

The U.S. Drug Enforcement Agency (DEA), in charge of the Drug War, reports that during the course of one year, that is, in collaboration with its allies, intercepts, confiscates and destroys 10% of the illegal drugs from the inventory in the supply chain, in the United States.

This annual interception is considered for the purpose of this thesis as occurring in one single day, as this has a physical and immediate crime-stopping impact far beyond an interdiction spread over one year (365 days).

An initial and optimistic view of interdiction predicts that, upon an annual interdiction of approximately 10% of supply Quantity, the value of the illegal drug remaining as inventory in the supply chain decreases (practically nothing); while a more detailed analysis demonstrates that the value of the illegal drug remaining in the supply chain actually increases counter intuitive! This is because, for those suppliers lucky enough to have no interdicted product, the

selling price of their product spontaneously increases by approximately two times.

“One of the major problems with supply reduction efforts (source control, interdiction, and domestic enforcement) is that “suppliers simply produce for the market what they would have produced anyway, plus enough extra to cover anticipated government seizure” [Interdiction of Drugs: Drug War Facts. (n.d).Retrieved from http://www.drugwarfacts.org/cms/Drug_Interdiction].

“Interdiction efforts intercept 10-15% of the heroin and 30% of the cocaine. Drug traffickers earn gross profit margins of up to 300%. At least 75% of international drug shipments would need to be intercepted to substantially reduce the profitability of drug trafficking” [Interdiction of Drugs: Drug War Facts. (n.d). Retrieved from http://www.drugwarfacts.org/cms/Drug_Interdiction].

Assumptions for the analysis of Drug Trade

The basics of the supply-and-demand approach provide a useful analytical framework to understand markets for illegal drugs. Conceptually, after some analysis, we will draw to a conclusion about drug legalization. The economic approach is flexible enough to capture many of the special features of the illegal drug markets, and provides important insights.

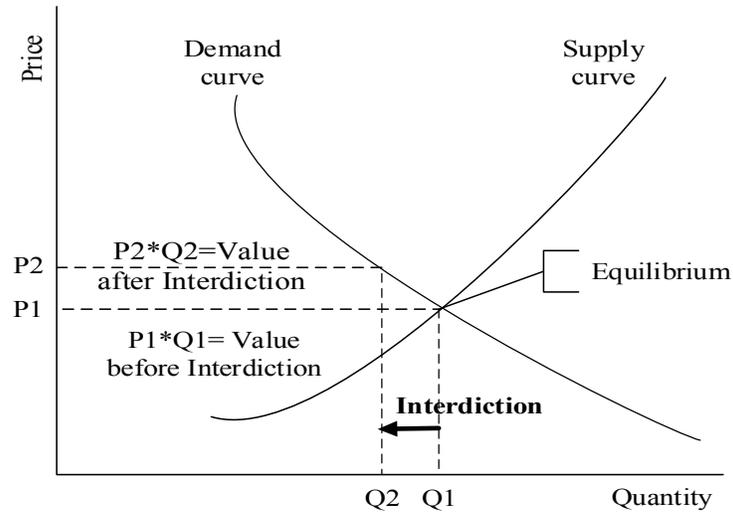


Figure 20: Value of drug in the supply before and after interdiction
[Wisotsky, 1990]

Figure 20, demonstrating that an interdiction of 10%/ 15 % results in an increase in value of the inventory in the supply chain and counter intuitively a corresponding increase in production. Contrary to current political rhetoric, interdiction of illegalized drugs may actually result in an increase of value of the drug inventory in the supply chain. The area of rectangle $P1*Q1$ is the value of a drug inventories in the supply chain before interdiction. After interdiction, the total value of the drugs still in the possession of traffickers, $P2*Q2$, has actually increased.

Consequently, the interdiction serves more as increased demand rather than as a penalty or a deterrent. The sudden jolt of an annual interdiction in one day never takes place. The 10 % interdiction occurs over the course of one year.

5.2 Positive Feedback section

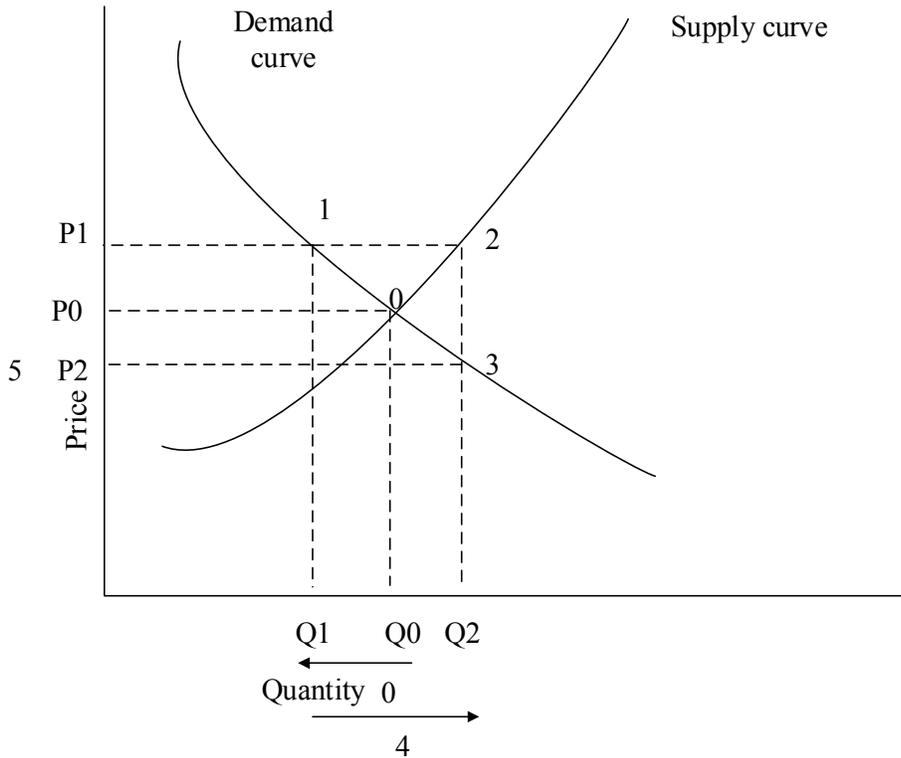


Figure 21: Positive Feedback

From Figure 21, before interdiction the quantity demanded is Q_0 at price P_0 , after interdiction the quantity demanded is Q_1 and sold at higher price P_1 . At this point Q_1 and P_1 , there is an impact on supply curve making the quantity demanded as Q_2 and price P_2 , which implies more quantity is demanded and sold at lower price, which implies interdiction has no effect.

The equilibrium is a small rectangle vibrating the original intersection. If cocaine is considered as a currency based on a physical commodity, interdiction serves to moderate the inflation that devalues fiat currencies over time; that is cocaine becomes a perpetual renewing store of value.

5.3 Impact on Traffickers

The interdiction also systematically and relentlessly eliminates the smaller and less competent drug transporters who become more influential, intelligent, more ingenious, and greatly more capitalized and needless to say, more skilled in bribery and brutality, vastly more capable of enforcement.

The Drug Transporters become like a super breed through evolution their capital eventually exceeds the defense budgets of most nations, including those of Central America and even Mexico. The price support system imposed by the strategy of interdiction foments the criminal activities of hard core addicts, of criminal gangs dedicated to kidnapping and extortion and of course, the corruption of national armies, national police and government officials.

5.4 U.S. Government Involvement

The analysis also brings up the very nasty conclusion that the U.S. Spy Organizations, CIA, FBI, DEA, with plenty of computer geeks, analysts and experienced field agents have known about the futility of interdiction in the Drug War for some 42 years and to preserve their jurisdictions have never forcefully argued and convinced the authorities in the Presidency and in U.S. Congress.

We don't know how accurate the DEA statistics are: because as a major player in the game the DEA has its own agenda.

5.5 Fragmentation of Government

Columbia was once famous for two Cartels, Medellin and Cali; This Dual Monopoly has broken down in to some 300 smaller organizations which has made detection much more difficult and facilitates multiple possible sources of bribery and corruption.

The Envigado in Medellin has emerged as an informal brokerage for buyers and sellers: curiously the Envigado does not make war on the DEA of the United States: rather it acts as a protection agency for DEA agents. If there were a real war, DEA agents would be falling dead at the rate of 20 or 30 a month, Mexico is following the fragmentation mode, with many small organizations in rural, urban, and border areas. Paradoxically the united states subsidize this fragmentation with programs such as operation Merida (1.5 billion dollars) and periodic injections of free cash.

Chapter 6

Conclusion

The basics of supply-and-demand and system dynamics approach provided a conceptual framework to understand and capture the features of interdiction in illegal drug markets, and provided important insights.

In order to starve cartels and traffickers of drug profits, and to remove the pervasive Americas-wide temptation for everyday people to become involved with illegalized activities, as well as the trend for governments to become hyper-militarized and corrupted, economic analysis points to the legalization of drugs.

Legalization would radically reduce violence and save the lives of new entrants, lured by a personal risk premium that is psychologically overlooked.

Legalization would leave the hard core addicts in place and would increase drug use in the general population due to lower prices; this would have to be dealt with as a medical and social problem. Legalization would reduce or eliminate criminal behavior and corruption in national armies, national police and national governments. Legalization would radically reduce violence and save lives, particularly in Mexico and Central America.

Appendix: Data Sources

Below are the results of National survey on drug use and health in the year 2005, showing estimates of the US population aged 12 and above who admit to using substances:

Substance	Ever used	Past year	Past month	Frequent users
Alcohol	201.67 82.9%	161.63 66.5%	126.03 51.8%	16.04(heavy users) 6.6%
Tobacco	172.28 70.8%	84.96 34.9%	71.52 29.4%	N/A
Marijuana	97.55 40.1%	25.38 10.4%	14.63 6.0%	N/A
Cocaine	33.67 13.8%	5.52 2.3%	2.34 1.0%	N/A
Crack	7.93 3.3%	1.38 0.6%	0.68 0.3%	N/A
Heroin	3.53 1.5%	0.38 0.2%	0.14 0.1%	N/A

The price of cocaine according to El Proceso magazine (no. 1999)

The price of a kilo of cocaine in the US is \$35,000, and in Mexico is \$15,000.

Marijuana Arrests and Total Drug Arrests in the US

Year	Total Drug Arrests	Total MJ Arrests	MJ trafficking Arrests	MJ possession Arrests	Total Violent Crime Arrests	Total Property Crime Arrests	Total Arrests (excluding simple traffic violations)
2005	1,846,351	786,545	90,471	696,074	603,503	1,609,327	14,094,186
2004	1,745,712	771,605	87,286	684,319	590,258	1,649,825	14,004,327
2003	1,678,192	755,186	92,300	662,886	597,026	1,605,127	13,639,479
2002	1,538,813	697,082	83,096	613,986	620,510	1,613,954	13,741,438
2001	1,586,902	723,628	82,519	641,109	627,132	1,618,465	13,699,254
2000	1,579,566	734,497	88,455	646,042	625,132	1,620,928	13,980,297
1999	1,532,200	704,812	84,271	620,541	644,770	1,627,100	14,355,600
1998	1,559,100	682,885	84,191	598,694	675,900	1,805,600	14,528,300
1997	1,583,600	695,201	88,682	606,519	717,750	2,015,600	15,284,300
1996	1,506,200	641,642	94,891	546,751	729,900	2,045,600	15,168,100
1995	1,476,100	588,964	85,614	503,350	796,250	2,128,600	15,119,800
1990	1,089,500	326,850	66,460	260,390	705,500	2,128,600	14,195,100
1980	580,900	401,982	63,318	338,664	475,160	1,863,300	10,441,000

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Vita

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