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An Application of the Bass diffusion model to border security and illegal immigration

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Abstract

This research's objective was to apply the Bass Diffusion model to border security and illegal immigration. The Potential Actual Illegal Immigration Population (PAIIP) model was created using the Vensim software program to illustrate and simulate illegal border crossings and assess the impact of detention, deportation, and amnesty on the communication between potential and actual illegal immigrants. This systems modeling approach combined with a secondary analysis method was used for data collection and analysis. Results indicate that no single or combination of policies solves the problem of illegal immigration. This study's conclusions point out that the greater the quality of information communicated between actual illegal immigrants that reside in the United States and potential illegal immigrants that live outside of the United States increases the probability of illegal crossings. Policymakers should ensure that institutions and agencies work in unison at the local, state, and federal level to deter illegal immigration and provide national security.

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I. Introduction

Using a systems modeling approach and the Vensim software program, the Potential Actual Illegal Immigration Population (PAIIP) model was created to theoretically illustrate and simulate illegal border crossings. The PAIIP model hypothesizes that the content of communication, or border crossivity, between actual and potential illegal immigrants stimulates illegal crossings. This study uses the PAIIP model to *illustrate* the effectiveness of detention, deportation, and amnesty on the ability to deter illegal immigration and terrorism. This research study also compares the amount of border security spending with the apprehension of illegal immigrants. The results from this study reveal that policies involving border protection and illegal immigration must work in unison on a local, state, and federal level in order to prevent violation of immigration law. Policies should explore the motivation and factors surrounding illegal immigration to ensure a safe United States and encourage legal entry.

I.1 What is the problem?

At least 10 million illegal immigrants reside in the United States of America (Hanson, 2007). Many of these are undocumented immigrants who overstay their visas. The Department of Homeland Security (DHS) did a study and estimated the visa overstay population in the United States to be at least 3.6 million out of an estimated 9 to 10 million illegal immigrants (Lipton, 2005). In 2004, Immigration and Customs Enforcement (ICE) received 301,046 leads on possible visa violators, but out of the 4,164 who were formally investigated, there were only 671 apprehensions (Lipton, 2005). With a large proportion of illegal immigrants overstaying their visas, the techniques used

towards their apprehension, as well as the prevention of this type of abuse, raises serious questions about the allocation of resources towards border patrol funding.

There are daily attempts to cross the northern and southern border of the United States by thousands of illegal aliens from Mexico, Canada, and countries all across the globe. After the tragic events of September 11, 2001, there is a fear that terrorists may sneak into the United States using the same smuggling networks as illegal immigrants from Mexico or Canada. In 2002 alone, a half million illegal immigrants entered the United States (Hanson, 2007, p. 25). Although the number of entrants into the United States does not add to the net growth rate of the illegal immigrant population since many of them return home each year, such behavior and potential annual growth in the visa overstay population and illegal alien population pose a major problem for the citizens and government of the United States.

The responsibility of maintaining border security and reducing illegal immigration is a huge financial endeavor that requires funding from the government. The three key public policy strategies that the United States government has used to tackle border security and illegal immigration are detention, deportation, and amnesty. The last time amnesty was granted to illegal immigrants living in the United States was under President Ronald Reagan's administration through the Immigration Reform and Control Act (IRCA) of 1986. Today there is a debate over whether or not amnesty should once again be granted to illegal immigrants. Other policy strategies which work simultaneously are surveillance on the border, e-verification, workplace raids, prosecution of employers who hire undocumented workers, and increased fencing.

With the election of President Barack Obama in 2008, a new administration has entered the White House with its own policy agenda and philosophy towards immigration reform. President Obama's administration also incorporates the public policy strategies of immigration raids, electronic technologies such as E-Verify, and an increase in border surveillance to combat illegal border crossings. As a Senator for Illinois in 2005, President Obama voted for the Secure Fence Act; the work on its construction is continuing (Reese, 2009).

Unlike President George W. Bush, President Obama's administration is exercising more patience and caution with immigration raids and has placed several delays on them by performing more analysis prior to raiding a worksite (Hsu, 2009). As a result, ICE is shifting its focus from detaining illegal workers to prosecuting employers who hire them and encouraging the use of E-Verify as a policy alternative (Hsu, 2009). Run by the Department of Homeland Security (DHS) and the Social Security Administration (SSA), E-Verify is a voluntary program that enables participating employers to verify the residency and employment eligibility status of their potential employees.

I.2 Why are Border Security and Illegal Immigration Public Policy Issues?

Any person who is not a citizen or national of the United States is an alien (Immigration and Nationality Act, 2009). An illegal immigrant is a person who enters the United States without official approval. Border security and illegal immigration are public policy issues because they impact the lives of Americans and the United States politically, economically, and socially. These three elements are not isolated; they are intertwined, because a policy remedy on one issue affects the other.

Many of the decision makers and stakeholders in politics and immigration reform are public policy officials throughout the executive, legislative, and judicial branches of the government. The policies implemented and enforced by these various branches provide national security to the United States. Legislation such as the Illegal Immigration Reform and Immigrant Responsibility Act of 1996 directly and indirectly affects citizens and immigrants who reside in America legally or unlawfully. The ratification of this act increased the attention placed on deterrence, stronger fencing was constructed in San Diego; the latest military technology was integrated for security; punishment for smugglers, migrants without documentation, and people who overstayed their visas became stricter; and finally, 1,000 new Border Patrol agent jobs were created (Massey, 2005).

Enforcing immigration law and securing the borders of the United States cost billions of dollars. Immigrants who cross the border illegally or overstay their visas find employment and utilize some of the resources the United States economic system offers such as education and healthcare. The economic relationship between America and Mexico is also a factor in immigration policy making. Between 1986 and 2002, the Immigration and Naturalization Service's (INS) budget increased from $474 million to $6.2 billion, and over the same time period the Border Patrol's budget increased from $151 million to $1.6 billion (Massey, 2005). As the number of Mexicans who entered the United States with business visas increased from 128,000 a year in 1986, to 438,000 a year in 2003, the total trade in goods and services between both nations increased over the same time period to approximately $235 billion (Massey, 2005). Based on these examples, border security and illegal immigration are economic public policy issues that

the government must address as they distribute funds to deter and prevent more growth in the number of undocumented immigrants.

Socially, most immigrants live in families with a blend of legal statuses, opportunities, and dreams (Gonzalez, 2009). In the event a family member faces detention and deportation, the likelihood of long-term or permanent separation makes policy making arduous, especially when there are children involved. Sometimes a child may be a natural born citizen of the United States, and either one or both of their family members are undocumented; such scenarios make policy solutions for border security and illegal immigration complex.

I.3 Why are Border Security and Illegal Immigration a Science and Technology Issue?

Border Security requires the latest scientific and technological innovations to capture potential illegal immigrants. The use of Unmanned Aerial Vehicles (UAVs) and Remotely Piloted Vehicles (RPVs) to deter illegal immigration and prevent terrorism is supported by Congress. UAVs and RPVs increase the number of hours and the distance border patrol can be enforced and can, therefore, improve the apprehension rate of illegal crossers (Blazakis, 2004, p. 3). Although new technology can increase border patrol efficiency, such advancements are costly. In 2008, President George W. Bush asked for $13 billion to enhance border security and immigration enforcement; $1 billion from this amount was proposed for fence construction and safety measures along Mexico's border (Hanson, 2007, p. 24).

Scientific and technological evaluation and risk assessment help to increase the probability that technologies used are reliable and safe. Innovative technologies, such as improved biometric data recognition and storage, UAVs, RPVs, and identification cards with radio frequency identification chips, imply that public policy officials must be cautious about the political, economic, and social ramifications of using scientific and technological tools to secure the borders of the United States.

I.4. Roadmap

The next section is a literature review which provides a background on border security and illegal immigration issues and policies such as chain migration, detention, deportation, and amnesty. After that is a section that presents the major research questions this study will attempt to answer. Next, there is a methodology section which summarizes the analytical processes and tools that were used in this study. Moreover, the methods section provides an explanation of the PAIIP model. Following that are the results from running the PAIIP model, as well as other quantitative border security and immigration data. Finally, the remaining chapters of this research study are the Discussion, Policy Recommendations, and Conclusion sections, which respectively highlight the key strengths and limits of this study.

II. Literature Review

The PAIIP model was designed using systems modeling to simulate illegal border penetration by potential illegal immigrants. First, the literature review will outline the current United States strategy towards providing border security and deterring illegal immigration. Next, it will present some of the motivations, consequences, and factors behind illicit border crossing. Because the PAIIP model provides a means towards policy analysis on detention and deportation and amnesty, the strengths and weaknesses of each of these policies will be discussed. Finally, border security spending will be compared to illegal alien apprehensions using a linear regression approach. Therefore, the qualitative and quantitative evidence presented in this literature review will provide the theory behind the PAIIP model's design.

II.1 Border Security Strategy of the United States

The present border security strategy of the United States encompasses the combination of the Obama administration's agenda as well as that of Immigration & Customs Enforcement (ICE) and Customs and Border Protection (CBP). President Obama has a five-point agenda for providing border security.

First, the Obama administration intends to provide additional support for the employees, systems, and technological resources along the borders and ports of entry of the United States. Second, Obama's administration would like to augment the number of legal immigrants to ensure that families stay together and, at the same time, fill the gap of unfilled jobs employers provide. Third, President Obama hopes to eradicate the encouragement of illegal immigration by tackling employers who hire workers with no

documentation. Fourth, the administration seeks to create a system such that immigrants without documentation but who are in good standing pay a penalty, learn the English language, and eventually gain a pathway to citizenship. Finally, the Obama administration would like to cooperate with Mexico by promoting fiscal development and decreasing illegal immigration (The Agenda • Immigration, 2009).

Under the CBP, the Office of Field Operations (OFO) has the primary responsibility of providing border security. Initiated in November 2005, the Secure Border Initiative (SBI) is a key component of the cooperation between both of these entities. SBI incorporates the use of the most advanced technological and tactical resources to maintain border security (Secure Border Initiative (SBI) Programs, 2009).

ICE has an annual budget of $5 billion. Since 2007, ICE has implemented new strategies towards deterring illegal immigration. These new strategies consist of improved management, focusing and targeting the most troublesome illegal immigrants as well as employers who violate immigration policies, and decreasing the amount of jobs that attract illegal aliens in search of work (Office of Detention & Removal (DRO), 2009). These employment opportunities refer to the job magnet, or the strong pull of jobs that cause immigrants to illegally cross the border (Kriikorian, 1999).

II.2 Motivations, Consequences & Factors Behind Illegal Border Crossings

In the United States, one in ten people are foreign born, and the largest groups are from Mexico, China, the Philippines, and India (The SH RM Learning System, 2006). Although the world's population is decreasing in the developed world, it continues to grow at a high rate in developing countries. The discrepancy in population growth is projected to speed up the inequality of income and financial opportunity and will cause

new pressures for migration and immigration both within and between nations (The SH RM Learning System, 2006).

There are many reasons why people immigrate to America. For instance, the United States and Mexico's economies play a huge role in whether or not there will be an illegal border crossing. Many immigrants illegally cross the border or overstay their visas because they can get higher paying jobs in the United States and thus make more money (Abraham, Hamilton, Meissner, Fix, Meyers, & Papademetriou, 2006). In 2005, over 50 percent of illegal migrants in the United States were of Mexican origin (Hanson, 2007). Moreover, when Mexico's wages for its workers decrease, attempts at illegal entry into the United States increase (Hanson, 2007). Therefore, an ailing economy or financial hardship is one reason that may motivate a person to risk their life to illegally enter the United States.

The strong desire to be with a friend, loved one, or family member also must not be overlooked. Such sentiments and conviction help justify why the possibility of detention and deportation do not prevent potential immigrants from illegal immigration. Hence, chain migration is a consequence of illegal border crossings.

Chain migration refers to a pattern resulting from one person already in the country helping a family member or friend enter the country. In turn, those same family members and friends bring their relatives and peers to the same nation or country to join them. In reference to both legal and illegal immigration, chain migration has a long history in the United States. The ability for aliens to utilize chain migration encompasses what quantitative studies call a "migrant stock variable" (Wegge, 1998, p. 959). The migrant stock variable represents the summation of all past migrants from a source area

or the total number of previous immigrants in a specific destination country. Typically it "represents the flow information between [immigrants and potential immigrants], or the family and friends effect" (Wegge, 1998, p. 959). In short, if the potential illegal immigrant knows someone in or has relatives in the United States the probability of an illegal border crossing is increased. Therefore, the greater and more reliable the flow of information in a network is the more likely it is that a migrant in one country will use that knowledge as a means towards moving to another unlawfully.

A factor that indirectly affects illegal border crossings is population growth. The potential impact of Mexico's population dynamics will be used as an example for discussion. During the latter part of the 20th century, as Mexico's overall population grew faster than the country's ability to provide jobs millions of illegal workers fled to the United States. Mexico's government began to encourage the use of and provide access to birth control for Mexican families. In doing so, the average Mexican family has decreased from seven children in 1960 to two in 2008 (Lange, 2009, p.1).

Despite the fact that over 11 million Mexicans left Mexico between 1970 and 2006 to come to America, some researchers believe that the flow of Mexican migration is decreasing. For example, Lange reports that in 2001 the annual average number of Mexicans who left Mexico reached a maximum of 600,000 but has been reduced to 440,000 in 2006. Such a decrease in the average amount of border crossings by Mexican nationals not only demonstrates the power of population factors but raises questions about border security spending such as extended fence construction. Nevertheless, according to Lange the Mexican minimum wage is $4 a day compared to the United States' federal hourly minimum wage of $6.55; this may ensure the continued illegal

migration of Mexicans, especially teenagers. Therefore, hundreds of thousands of Mexicans may continue to cross the border for the foreseeable future (Lange, 2009, p. 3). As population growth slows, however, this decreases the labor supply rendering labor more valuable, hence wages will increase in Mexico and we should expect a further slowing of out-migration as a consequence.

Economic motivations, chain migration, which is a consequence of illegal border crossings, and population growth factors impact migration rates. Other influential elements include political stability, the protection of civil rights, and other conditions that contribute to quality of life such as education, health care, and infrastructure.

II.3 Human Smuggling

Since 9/11 the United States government has consistently increased its spending on border security. However, since the southern and northern borders of America are not permanently sealed, holes still exist for illegal immigrants to exploit and penetrate.

Border security and illegal immigration require examination of the means by which an illegal immigrant may enter America. One method illegal immigrants may use to enter the United States that is an issue of concern is human smuggling. The Federal Bureau of Investigation (FBI) estimates human smuggling to be a multi-billion-dollar revenue generating business. While the fee for undocumented Mexicans to be smuggled across the border has risen from a couple hundred dollars to over a thousand dollars, people other than Mexicans (OTMs) pay at least ten times more than the normal base rate to be snuck into America. Some of the methods used by human smuggling networks include the use of adjusted tractor trailers with concealed sections for migrant transportation through legal ports of entry, working under the guise of legitimate

businesses, companies, and agencies and producing high-quality counterfeit documentation (Ewing, 2006, p. 6).

The policies regarding border security and illegal immigration have the potential to impact the lives of Americans and the United States economy. Therefore, in order to make prudent public policy decisions, the overall ability to reduce illegal border crossings must be assessed.

II.4 The Three Policy Strategies of the PAIIP Model

The PAIIP model simulates individually and in various combinations the policies of detention, deportation, and amnesty. The purpose of this section is to justify the incorporation of each policy into the PAIIP model as well as the theory behind its design. By discussing and comprehending the strengths and weakness of each policy better analysis of the PAIIP model's results will be achieved.

II.4.1 Detention and Deportation

The penalty for illegal entry into the United States is detention followed by deportation. Various facilities in the United States hold illegal immigrants such as the Corrections Corporation of America and the Geo Group. Although detention is a strong deterrent for illegal border crossings, the cost of maintaining this policy raises questions about its long-term effectiveness. The cost of a detention policy is very high. With nearly 30,000 illegal immigrants held on a nightly basis for an average cost of $95 per person the total yearly cost for detention is $1 billion. Instead of an increase in the number of people illegally entering the United States more prison space is needed due to the high number of illegal residents living in America and the expected increase in

apprehensions at the border (Kolodner, 2006). The United States government wants to place more immigrants in detention as they wait for their hearings, particularly those who are not from Mexico; the government no longer wants to discharge them "on their own recognizance, [because they] intend to end [what was previously known as] the catch and release era" (Kolodner, 2006).

The Office of Detention and Removal (DRO) has the primary responsibility of deporting the illegal immigrants they identify and apprehend. Although deportation is a strong and effective method for penalizing illegal immigrants, this policy has weaknesses. Once Congress passed the Immigration and Nationality Act of 1952 there has been a strong stream of illegal immigrants into the United States (Immigration Control, 1989). Because the process of deportation encompasses a judicial process, wherein a judge must decree the order of removal for an apprehended illegal immigrant, one of the main weaknesses for the policy of deportation is time. For example, the process of deporting an illegal immigrant may take five years or more. Since thousands of immigrants are deported annually, this research study assumes that the average time it takes to deport an illegal immigrant is one year. The reason for this time delay may be attributed to the

> coordination and liaison with foreign government officials and embassies to obtain travel documents and country clearances, coordinating complex logistical and transportation issues to repatriate the alien and, if required [the] DRO officers escort the alien to his or her foreign country (Office of Detention and Removal, 2009).

Despite the fact that deportation may be a time-consuming process its main strength is that it deters immigrants from violating United States immigration law. Human smugglers are also a subset of all those deported. Lastly, immigrants deported

from the United States are ineligible to return for a minimum time period of five years; the maximum penalty is life (Eschbach, Hagan, & Rodriguez, 2008).

II.4.2 Amnesty

The Department of Homeland Security, Immigration & Customs Enforcement (ICE), and Customs and Border Protection (CBP) have been revamped with the purpose of securing the United States' borders, wherein the penalty for apprehension is detention and deportation. However, another policy alternative that is presently in debate as a deterrent for illegal immigration is amnesty.

When the government pardons illegal immigrants for violating immigration laws that act is known as amnesty. The Immigration Reform and Control Act of 1986 (IRCA), the first United States amnesty act, was passed with the goal of controlling and deterring illegal immigration to the United States. It is estimated that under the IRCA of 1986, three million aliens were granted amnesty, and the two groups of illegal immigrants who were eligible for it were those considered residents of the United States before January 1, 1982 (Rytina, 2002, p. 2). Seasonal agricultural workers who were employed for at least three months prior to May, 1986 were legalized as well (Rytina, 2002).

Massey (2005) asserts that the IRCA of 1986 had four goals. First, the IRCA sanctioned employers who hired undocumented workers. Second, more resources were allocated to the Border Patrol. Third, it granted legalization to undocumented immigrants who could prove that they continuously resided in the United States for five years, as well as migrant farm workers. Finally, the IRCA expanded the executive authority of the President to declare an "immigration emergency" in the event of an actual anticipated increase in the entry of migrants into the United States (Massey, 2005).

According to President Obama, “if the American people don't feel like you can secure the borders, then it's hard to strike a deal that would get people out of the shadows and on a pathway to citizenship who are already here” (Hsu, 2009). With illegal immigration yet again being a controversial topic many policy analysts and scholars are debating whether amnesty should be granted again. A key element in this debate is whether or not the IRCA of 1986 actually deterred illegal border crossings in subsequent years. The IRCA of 1986 impacted legal immigration because amnestied aliens, as long as they possess permanent resident status or naturalized citizenship, have been fully eligible to sponsor additional immigrants (Rytina, 2001, p. 5). Sponsorship is not open to anyone; it is predicated on whether a person has been granted citizenship or permanent legal residence, and the specific family member sought after to be legally brought over into the United States. Hence, through subsequent chain migration, the policy of amnesty enables legal migration.

Amnesty is a complex debate with many sides. There are several different ideas being proposed. People support different legislation or ideas with various conditions. There are proponents and opponents of different amnesty proposals. While the views of proponents delineate the strength of an amnesty policy, the stance of its opponents highlights the weaknesses of legalization as well. General amnesty supporters consist of labor unions such as the AFL-CIO, religious institutions such as Christian coalition groups and the Catholic Church, and Congress members such as Senator Richard Durbin. Immigration lobbyists for amnesty also encompass business and human rights organizations.

One of the main reasons that there are amnesty advocates is that they believe it would “save politically unacceptable mass deportations” (Hanson, 2007, p. 30). Other arguments people make for amnesty is that it prevents the exploitation of illegal immigrants who employers knowingly hire, and it keeps families together, especially those with children. Families in this situation are referred to as mixed-status families (Gonzalez, 2009). The Pew Hispanic Center reports that nearly four million children in the United States have at least one parent who illegally entered and is not a citizen; 80 percent of these children live in two-parent family homes (Drash, 2009).

Amnesty opponents do not approve of rewarding violators of immigration law with a pathway to citizenship (Hanson, 2007). Many opponents point towards the surge in illegal immigration after the IRCA of 1986 was passed as proof that legalization does not work (Hanson, 2007, p. 30). Opponents of legalization would like to see a shift towards the creation of more jobs for American citizens. They are also weary of the cost for legalization programs. Ten years (1987-1997) after the United States granted amnesty to illegal immigrants the Center for Immigration Studies did a study and found that the cost of legalization was approximately $78.7 billion (Simcox, 1997). Factoring in the indirect and downstream costs the study revealed that the amnestied population accounted for an estimated $102.1 billion in 20 federal, state, and local assistance programs and services and that the $78 billion in paid total taxes resulted in a ten-year fiscal deficit of $24 billion in the public assistance and services portion of the budget (Simcox, 1997). Instead of this financial burden, amnesty opponents advocate that more fiscal resources be allocated towards border security such as an increase in border patrol agents, fence building, and innovative technologies.

Immigration policy reform is open to criticism no matter what the policy remedy. In reference to amnesty, the ramifications of any type of legalization program must be thoroughly assessed.

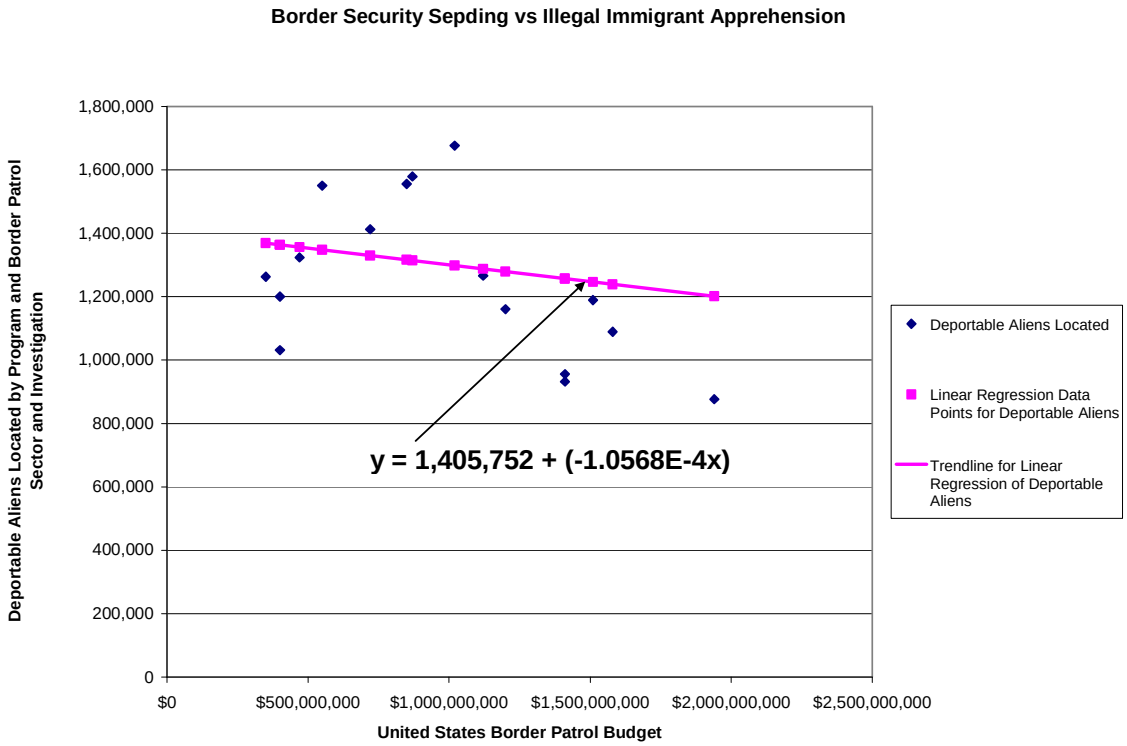
II.5 Border Security Spending vs Illegal Immigrant Apprehension: A Linear Regression Approach

The purpose of this section is to ascertain whether or not spending more money on border security results in a significant deterrence in illegal immigration. Apprehension, detention and deportation, and Border Patrol require funding. For example, "in 2006, with the already huge increases in spending, the flow of illegal immigrants across the southern border (as measured by apprehensions) fell by 27 percent" (Hanson, 2007, p. 25).

Table 1

Year	US Border Patrol Budget	Total Deportable Aliens Located By US Border Patrol	Total Linear Regression of Deportable Aliens [y= 1,405,752 + (-1.0568E-4x)]
1992	$400,000,000	1,199,560	1,363,480
1993	$350,000,000	1,263,490	1,368,764
1994	$400,000,000	1,031,668	1,363,480
1995	$470,000,000	1,324,202	1,356,082
1996	$550,000,000	1,549,876	1,347,628
1997	$720,000,000	1,412,953	1,329,662
1998	$850,000,000	1,555,776	1,315,924
1999	$870,000,000	1,579,010	1,313,810
2000	$1,020,000,000	1,676,438	1,297,958
2001	$1,120,000,000	1,266,214	1,287,390
2002	$1,140,000,000	955,310	1,256,742
2003	$1,140,000,000	931,557	1,256,742
2004	$1,200,000,000	1,160,395	1,278,935
2005	$1,510,000,000	1,189,031	1,246,174
2006	$1,580,000,000	1,089,096	1,238,777
2007	$1,940,000,000	876,803	1,200,732

Chart 1



The Department of Homeland Security (DHS) provides statistics on deportable aliens located by the border patrol sector each year. The border patrol is spread out through numerous locations in the United States. In Appendix A, Table 3 indicates how the Border Patrol breaks down its patrolling areas into two sectors, the southwest sector and other sectors. The southwest sector consists of cities in the states of California, Arizona, and Texas such as San Diego, Tucson, and El Paso, respectively. The other sectors encompass different cities such as Buffalo, New York, Miami, Florida, and Swanton, Vermont.

The exponential growth in the amount of money spent on border patrol raises the question of whether the United States has been able to successfully deter immigrants from illegally crossing the border, and locate illegal aliens residing in the United States.

A linear regression T Test was used to assess cost effectiveness of border security spending versus the number of deportable aliens located by the Border Patrol. The equation of the linear regression line was plotted in the form $y = B_0 + B_1x$. All original and projected data have been recorded in Table 1 and plotted in Chart 1 of this section.

The focus of the linear regression T Test is the slope, B_1, of the regression line; it is also referred to as the regression coefficient. The regression coefficient for this statistical analysis is important because it provides insight into the relationship between border patrol spending and the apprehension of illegal immigrants. A B_1 greater than zero denotes a positive and direct relationship between spending and deportable alien apprehension; this implies that an increase in spending results in an increase of apprehensions. A B_1 lower than zero indicates a negative and inverse relationship between spending and apprehension; thus an increase in spending results in a decrease of deportable aliens apprehended. Finally a B_1 equal to zero implies no relationship between apprehension and spending.

The equation for the regression line is y = 1,405,752 + (-1.0568E-4x); it was derived from the plotted data for the dependent variable, Deportable Aliens Located by Program and Border Patrol Sector and Investigation, and the independent variable, United States Border Patrol Budget, from 1992-2007. The linear regression equation is also a cost function, Deportable Aliens Located = f($); inputting the border patrol budget values into the cost function, $Y = f(X_1, X_2,\ldots X_n)$, provides the projected annual number of deportable aliens located by the border patrol.

The results from the Linear Regression T Test show that B_1 is equal to -1.056E-4, and that the regression equation projects a downward slope for the plotted data. The standard error for the regression equation, s, is 227,094. The standard error for the slope, s_{b1}, is 5.3778E-5. The test statistic, t, is -1.9651; the P-value, p is .0348; and the degrees of freedom, df, is 14. The correlation coefficient (goodness of the fit) for the regression line, r^2, is .22, or 22%. The results from the Linear Regression T Test indicate that there is an inverse relationship between border patrol spending and apprehension; the exponential increase in border patrol spending does not correlate with an increase in apprehensions.

According to Massey (2005), the cost for the apprehension of an illegal immigrant by the Border Patrol has increased from $300 in 1992 to $1,700 in 2002. The increase in border enforcement has pushed immigration rates to more remote locations; this has resulted in a higher rate of death along the border, forced illegal immigrants to remain in the United States longer, and caused a significant decline in apprehension rates (Massey, 2005).

The linear regression technique used in this section is a simple analytical tool used for projection. The results from this method are merely theoretical. Since the type of deportable alien located by the Border Patrol is not reported in the data set used the policy analysis technique of a Linear Regression T Test is neither strong enough to help understand the broader scope of illegal immigration nor provide viable policy recommendations. However, this technique does form a foundation towards further research on the problem of illegal immigration.

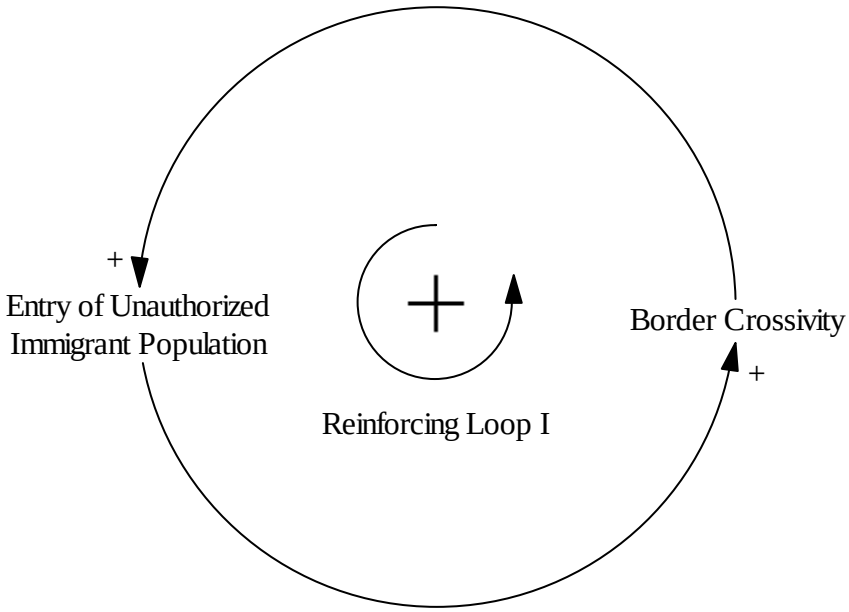
Consequently, another relevant policy analysis technique is systems modeling. Therefore, the construction of causal loop diagrams was a crucial piece towards developing the PAIIP model.

II.6 Causal Loop Diagrams

Causal Loop Diagram 1 (CLD 1) captures the main argument of this research study and the driving force behind the PAIIP model. CLD 1 has a reinforcing loop. The impact of one variable on another variable along a reinforcing loop may be uniformly positive or negative, positive meaning that an increase in one variable causes the other to increase, or negative implying that an increase in a variable causes the other to decrease.

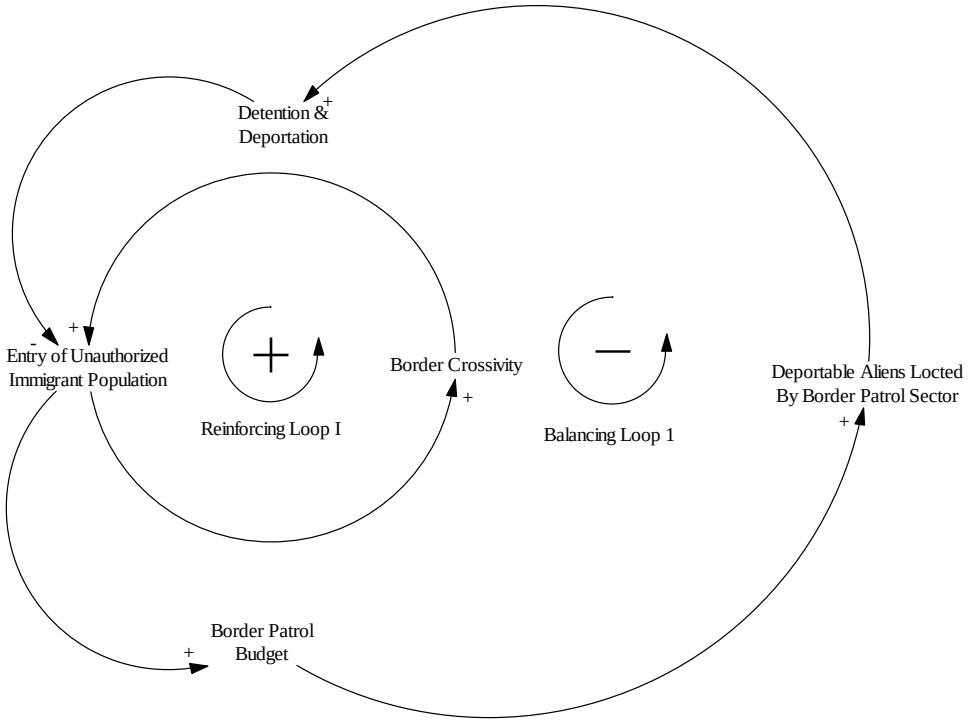
CLD 1 asserts that an increase in border crossivity causes an increase in the entry of unauthorized immigrants into the United States and that an increase in the entry of unauthorized immigrants causes an increase in border crossivity. Border crossivity represents communication between immigrants who reside in the United States and those who live outside of America. More reliable and qualitative the content of the discussion and information between actual illegal immigrants and potential illegal immigrants stimulates illegal border crossings and contributes towards the undocumented population in the United States. Edwards (2006) argues that both legal and illegal immigration are inextricably related. He also asserts that chain migration connects legal and illegal immigration; this implies that even though immigrants who either obtain citizenship or come to America legally may bring over their relatives and friends there are still instances in which legal and illegal immigrants contribute towards illegal border crossings.

Causal Loop Diagram 1



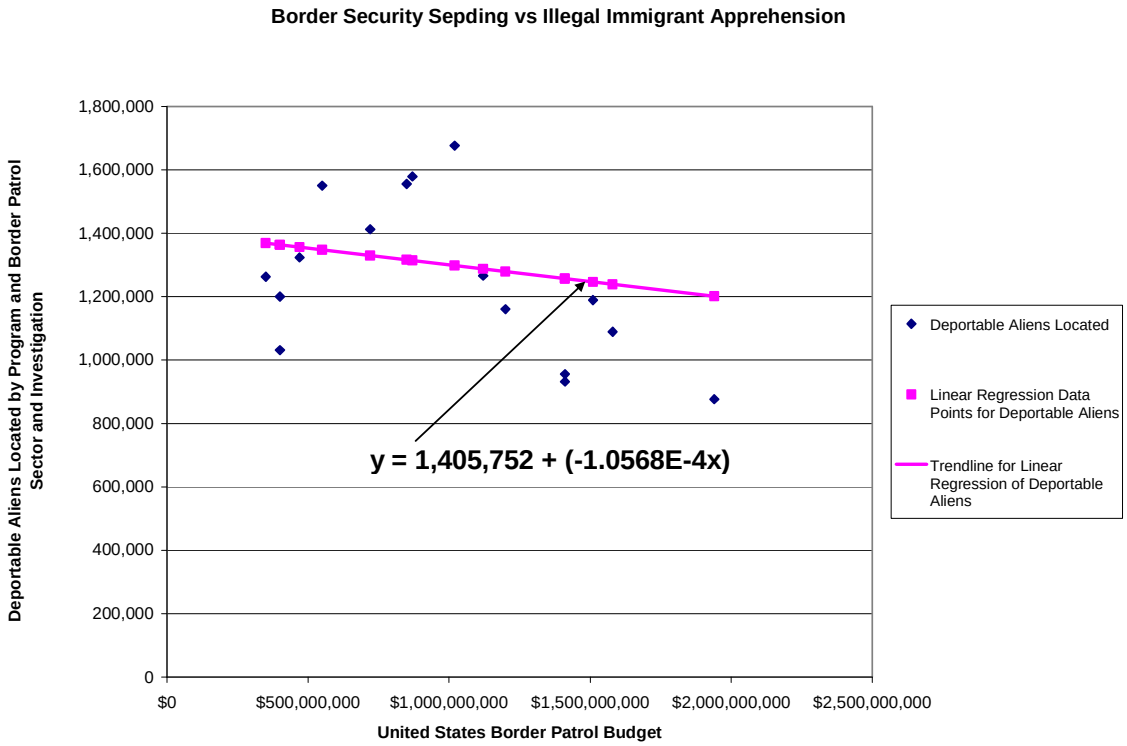
Causal Loop Diagram 2 (CLD 2) is an expansion of CLD 1. CLD 2 has a balancing loop. Variables along a balancing loop are neither uniformly positive nor negative. The causal relationship between variables along a balancing loop is both positive and negative. Thus, as one variable increases, it may cause the other to increase or decrease.

Casual Loop Diagram 2



CLD 2 illustrates the relationship between border patrol spending and apprehension. CLD 2 asserts that an increase in the entry of unauthorized immigrants causes an increase in the Border Patrol's budget. An increase in the Border Patrol's budget causes an increase in the deportable aliens located. An increase in the number of deportable aliens located causes an increase in detention and deportation, and an increase in detention and deportation causes a decrease in the entry of unauthorized immigrants. Although an increase in spending should cause an increase in apprehensions this research study argues that an increase in spending does not correlate with an increase in apprehensions. Chart 1 below demonstrates and supports this argument.

Chart 1

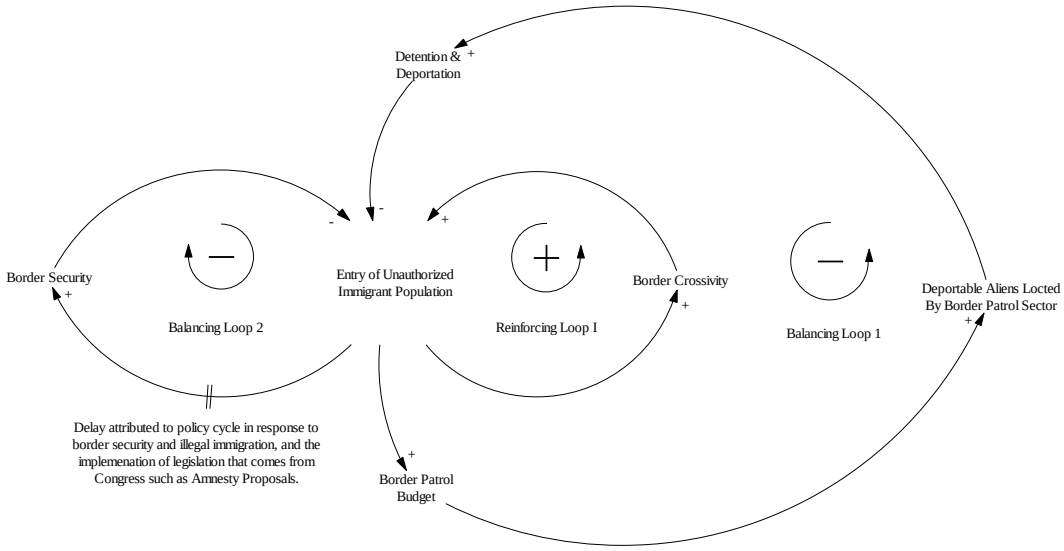


Since 1965, American immigration laws encouraged the reunification of families and thus provided a mechanism for migrants with family ties to legal aliens to chain migration (Wegge, 1998). Yet, immigrants are still illegally crossing the border or overstaying their visas making it very arduous for the government to adequately respond with the necessary and proper legislation to deter this behavior in a timely fashion. Balancing Loop 2 in Casual Loop Diagram 3, CLD 3, tries to capture the difficulties of the government's response to illegal border crossings.

CLD 3 is an expansion of CLD 2 and is the final causal loop diagram of this section. With the third and final piece incorporated, CLD 3 argues that the entry of unauthorized immigrants causes an increase in border security, and an increase in border security causes a decrease in the entry of unauthorized immigrants. The increase in

border security may stem from new legislation or mandates from the government, the allocation of more money, or the strategic movement of funds to programs and initiatives that work best. However, sometimes there tends to be a delay in legislation to fight illegal immigration. One reason for the delay is attributed to the policy cycle and its ability to respond to illegal immigration and border security measures in a timely fashion. For example, the creation of the Department of Homeland Security after September 11, 2001, took time as various agencies were reorganized. Another reason for the delay may be the current amnesty debate.

Causal Loop Diagram 3



With a single reinforcing loop and two balancing loops, the components of CLD 3 illustrate the political, economic, and social impact of illegal migration on border security. Most importantly, CLD 3 provides a framework towards understanding the PAIIP model and attempts to describe the causes and effects that stimulate the entry of illegal immigrants.

III. Research Questions

As we have seen, the United States government, although it relies on several others as well, has focused on three policies – detention and deportation, and amnesty – in its effort to reduce illegal migration. Since the United States government has increased its spending on border security, it is important to know which policy or combination of polices work best at reducing illegal border crossings. The PAIIP model will try to illustrate the following:

1. **Which policy or combination of policies has the best chance of limiting illegal migration?**

The PAIIP model is an illustrative policy analysis tool that was developed to primarily study the impact of detention and deportation and amnesty on the communication between potential and actual illegal immigrants, as well as how these policies affect illegal border crossings. The results from the PAIIP model's cases will provide an innovative way to examine the problem(s) behind border security and illegal immigration.

2. **What does the United States government, its organizations, and agencies that provide border security need to be successful at executing their agenda and goals?**

The cost to apprehend, detain, and deport illegal immigrants continues to increase. For instance, in 2001 the Immigration and Naturalization Service spent $4.2 billion on border and interior enforcement which included the detention and removal of illegal aliens. Such spending on detention and deportation factor into the debate on amnesty, especially since the IRCA of 1986's ratification has cost taxpayers billions of dollars.

Furthermore, some opponents of legalization do not see the logic in spending taxpayer money on border security and then rewarding non-citizens with a pathway to citizenship. Therefore, in reference to border security spending, detention and deportation, and the amnesty debate, the PAIIP model's results will be interpreted to address the resources border security needs to be successful in achieving its goals.

IV. Methods

In order to understand the immigration problem it is important to understand what causes illegal entry into the United States. Some of the reasons that cause illegal entry are:

a. There exist three primary smuggling corridors along the southern border of the United States: the South Texas, West Texas/New Mexico, and California/Arizona corridors.
b. Illegal migration is motivated by the search for employment in the United States and other factors such as education, healthcare, and political asylum.
c. Chain migration is a consequence of illegal crossings.
d. Population growth is a factor towards illegal migration.
e. Human smuggling is an annual billion dollar enterprise immigrants use to illegally penetrate the United States' borders.

Causal Loop Diagram 3 (CLD 3) delineates how communication between potential and actual illegal immigrants stimulates the entry of illegal immigrants. CLD 3 also describes the impact of government legislation and border security spending on the entry of unauthorized immigrants. However, a causal loop diagram is a limited means for providing an explanation for the immigration problem because the dynamics of illegal immigration are very complex. Therefore, using systems dynamic modeling helps increase our understanding of the situation and will better assist policymakers, CBP, and ICE towards dealing with the problem of illegal immigration and most importantly help secure the United States' borders. Using secondary data analysis, the purpose of the methodology in this study is to compare and contrast border patrol spending versus

illegal immigrant apprehension, and to simulate the effects of detention and deportation and amnesty on the communication between potential and actual illegal immigrants, and illegal border crossings. The steps are outlined below.

1. Immigration and border security data were collected from the United States' Department of Homeland Security (DHS) website and the Data360 website.
2. The data from the DHS and Data360 website were plotted on a graph. The data was used to perform a Hypothesis Test for the Slope of a Regression Line, also referred to as a Linear Regression T Test.
3. The results from the Linear Regression T Test were plotted in the form $Y = B_0 + B_1X$. B_0 is a constant. B_1 is the slope or regression coefficient. X, border patrol spending, is the value of the independent variable. Y, deportable aliens located, is the value of the dependent variable.
4. There were two hypotheses:

   The null hypothesis → H_0: $B_1 = 0$

   The alternative hypothesis → H_a: $B_1 < 0$
5. The null hypothesis, H_0, was rejected, and the alternative hypothesis, H_a, was accepted.
6. Causal loop diagrams were designed and developed to explain the theory behind the PAIIP model and some of the political, economic, and social issues surrounding border security and illegal immigration.
7. A systems model entitled the Potential Actual Illegal Immigration Population (PAIIP) model was designed to simulate communication between potential and actual illegal immigrants and illegal border crossings.

8. The PAIIP model has two cases: Detention and Deportation and Detention and Deportation with Amnesty
9. Discussion and analysis on the dynamics of the PAIIP model and its two cases.

IV.1 Systems Modeling for Illegal Border Entry

The PAIIP model was developed using systems modeling as a policy analysis tool that may be applied towards understanding the dynamics of illegal border crossings. First, the PAIIP model's origins and its connection to terrorism are articulated. Next, this section presents the dynamic hypothesis of the PAIIP model. Then, the mathematics behind the base case's design and ability to simulate illegal migration are presented. Finally, the building block models for the PAIIP model's cases are discussed.

IV.1.1 Potential Actual Illegal Immigration Population (PAIIP) Model & Its Connection to Terrorism

The PAIIP model originated from the concept and design of Kermack and McKendrick's (1927) SIR model and the Bass Diffusion model. Sterman (2000) states that in a systems model, stocks are accumulations that characterize the state of the system and generate the information upon which decisions and actions are based and that flows drive the rate at which stocks change. During a model simulation or run for policy analysis, policy levers are tools that a policy actor/decision maker may adjust by either increasing or decreasing to observe what the policy implications are for the chosen variable(s).

The "SIR model, which stands for Susceptible population, S, the Infectious population, I, and the Recovered Population, R, is a model for understanding the dynamics of epidemic diseases" (Sterman, 2000, p. 303).

> [The] Bass Diffusion model simulates the phenomena of rumor spreading and new ideas, the adoption of new technologies, and the growth of new products, because they too may be viewed as epidemics (Sterman, 2000, p. 323).

While the SIR model has three stocks, two flows, and four policy levers, the Bass Diffusion model has two stocks and three policy levers.

Since policymakers are concerned that terrorists may use the same illicit methods as illegal immigrants to enter the United States, the PAIIP model's cases become analytical tools that may help the government, ICE, and CBP deter or prevent terrorism. For instance, in the PAIIP model base case the process of detention and deportation delineates how an actual illegal immigrant or terrorist is apprehended, deported, and returned into the potential illegal immigrant population. Yet, detention and deportation are only two strategies towards deterring illegal immigration and the potential threat of terrorism. The policy of amnesty is incorporated into the PAIIP model's second case as well.

IV.1.2 Dynamic Hypothesis

The key behind the PAIIP model's dynamic hypothesis of communication between potential and actual illegal immigrants lies within the fundamental assumption of the Bass Diffusion model. The Bass Diffusion model, which has a Potential Adopters stock and an Actual Adopters stock, is based on the assumption that the adoption of a product or service such as cable television is attributed to the spread of the service by

word of mouth. Moreover, "there are several channels of awareness that can stimulate early adoption of new innovations besides word of mouth and related feedback effects that depend on the size of the adopter population, such as adversting, media reports, and direct sales efforts" (Sterman, 2000, p. 332).

The dynamic hypothesis of the PAIIP model is that:

> The communication between illegal aliens in the United States and potential aliens outside the United States via word of mouth in all its forms, verbal, manual, or digital, stimulates illegal border entry and activity.

IV.2 Detention and Deportation (Base Case) Explanation

This section discusses and presents the mathematical formulas that enable the calculation of the variables in the PAIIP model's base case. The base case is important because the second case is derived from it[1].

$PIIP = \int (-BCR, N - AIIP_0 - IIAP_0)$

$AIIP = \int (BCR - AR, AIIP_0)$

$IIAP = \int (AR, AIIP_0)$

The communication between the AIIP and the PIIP is captured by the parameter Illegal Immigration Contact Rate, iicr. This form of communication is analogous to word of mouth via various modes of communication such as telephones, the Internet, and written letters. Therefore, the PIIP generates: PIIP*iicr contacts per time period.

The time period for this model is the amount of people contacted over the course of a year between the AIIP and the PIIP. Border crossivity, which is the probability of a random encounter between a person from the AIIP and the PIIP, makes the PIIP

[1] Potential Illegal Immigrant Population = PIIP, Actual Illegal Immigrant Population = AIIP, Illegal Immigrant Apprehension Population = IIAP, Border Crossing Rate = BCR, Apprehension Rate = AR, Total Population = N

susceptible towards crossing the border. The probability of a random encounter is, AIIP/N.

The IIAP is based on the percentage of AIIP caught at the border. To get the actual value of the amount of time it takes to rid the country of illegal aliens, one needs to know how long it takes for a person to be deported and sent back into the PIIP. Therefore, the delay fixed function is used in the base case because it takes time to locate, apprehend, and deport an illegal alien after he or she crosses the border.

IV.3 Potential Actual Illegal Immigration Model (PAIIP) Building Block Model (BBM)

The Potential Actual Illegal Immigration (PAIIP) model has two distinct cases. This section discusses the building block models for both of them. Building block models are analogous to blueprints; they are descriptive outlines and maps that provide both the systems modeler and policy actor with a detailed visual of a systems model. In this section, the concept, diagram, and units of each case will be presented and will assist in providing a stronger comprehension of the feedback mechanisms behind the function and design of the PAIIP model.

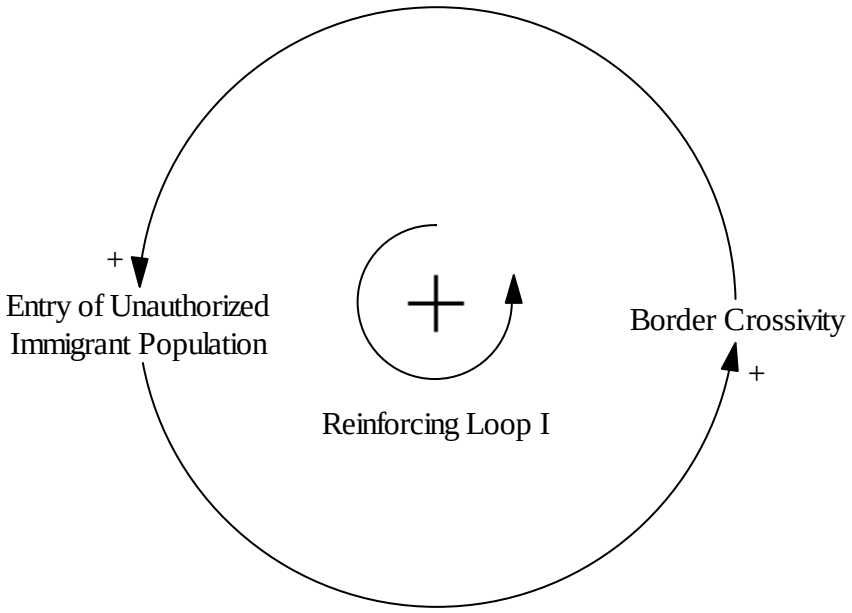
IV.3.1 Detention and Deportation Building Block Model Description (BBM)

The primary purpose behind the application of the Bass Diffusion model to border security and illegal immigration is to examine the issue of communication and contact between actual and potential illegal immigrants. Since CLD 1 asserts that an increase in border crossivity (bc) causes an increase in the entry of illegal immigrants, an illegal

immigration contact rate (iicr) parameter was embedded into the Detention and Deportation base case's design. The border crossivity and iicr policy levers are both key variables in the PAIIP model's base case. They may be adjusted to illustrate how the content of information and contact between actual and potential illegal immigrants creates and impacts border crossings. Though the argument about the quality of information and contact between actual and illegal immigrants is not measurable or quantifiable, the role of the border crossivity and iicr policy levers in the PAIIP model is to attempt to theoretically simulate the phenomena of information communicated between actual and potential illegal immigrants.

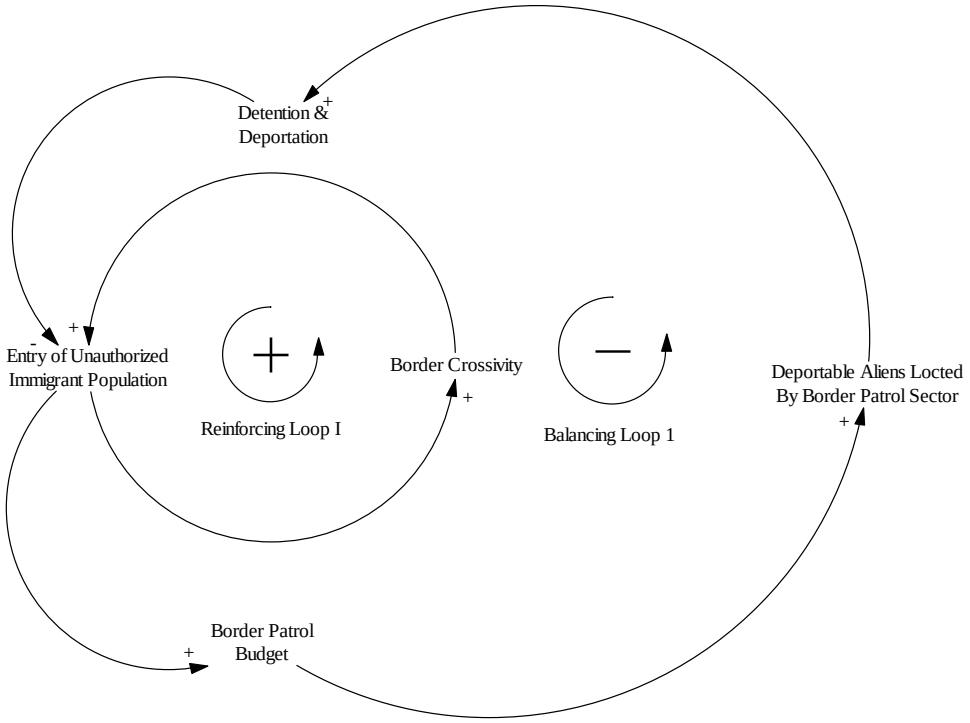
The values for the border crossivity and iicr are inputted into the PAIIP model, and they have units of percentage and population per year respectively. While border crossivity is based on a scale from 0 to 100%, the iicr ranges from 0 to whatever number a policy actor selects. A border crossivity or iicr value of 0 implies no communication and results in no illegal activity. However, so long as the iicr is greater than zero, when the border crossivity policy lever is increased, border crossings occur. The maximum value of 100% for the border crossivity variable implies that the most reliable and best information is being provided by the actual illegal immigrant to the potential one. Thus, an increase in border crossivity represents an increase in the quality of information shared between actual and potential illegal immigrants; the stronger the content of information is the greater the probability that an illegal crossing will take place.

Causal Loop Diagram 1



CLD 2 encompasses the dynamic of apprehension and detention and deportation. It also asserts the argument that an increase in these policies decreases the entry of illegal immigrants. In the base case, the border crossivity and iicr variables affect, or are impacted by, these factors incorporated into the model as stocks, flows, and other policy levers. Moreover, these additional variables highlighted in CLD 2 provide a foundation for analysis of the PAIIP model's behavior and results. Hence, the base case has three stocks, three flow variables, and three more additional policy levers.

Casual Loop Diagram 2



The Potential Illegal Immigrant Population (PIIP), the Actual Illegal Immigrant Population (AIIP), and the Illegal Immigrant Apprehension Population (IIAP) represent the stocks of the Detention and Deportation base case. In the PAIIP model's base case, Potential Adopters was replaced with the PIIP stock, and Actual Adopters was replaced with AIIP stock. Given that the SIR model is analogous to the Bass Diffusion model, the PIIP and AIIP stocks in the PAIIP model's base case also replace the Susceptible Population and Infected Population stocks in the SIR model. The units for the PIIP, AIIP, and IIAP stocks are population. Any value equal to or greater than 0 may be inputted for them. Thus, the number of border crossings not only depends on border crossivity and the iicr but also on the size of the AIIP and PIIP.

Each stock in the Detention and Deportation model is connected by a flow. There are three flow variables in the model: the Border Crossing Rate (BCR), the Apprehension

Rate (AR), and the Deportation Rate (DR). The units of each flow, BCR, AR, and DR are population per year. These flow variables are calculated by the PAIIP model. What determines and affects their behavior are the various policy levers that can be adjusted during a run or simulation of the model. The primary policy levers that directly affect the BCR, which in turn is dependent on the size of the AIIP and PIIP, are the border crossivity, iicr, and Total Population (N).

Like the SIR and Bass Diffusion models, the PAIIP model has a Total Population policy lever. The Total Population's value is inputted and adjusted by the user. If this parameter is set to zero, no activity occurs. Given that the SIR model predicts the infection rate, and the Bass Diffusion model projects an adoption rate, the power of the bass model's incorporation into the PAIIP model is that it enables the calculation, simulation, and projection of the amount of illegal border crossings based on the total population of illegal immigrants assumed to be communicating with each other. In addition, the Bass Diffusion model helps simulate the probability that there will be sufficient enough information for an attempt at illegal entry into the United States. Therefore, the rate of illegal entry is captured by the border crossing rate flow variable.

The apprehension rate is a flow and the Illegal Immigrant Apprehension Population (IIAP) is a stock because "the SIR model's recovered population is often termed 'removals' and the recovery rate is then called the removal rate" (Sterman, 2000, p. 304). The apprehension rate has a unit of population per year and flows into the IIAP. Out of the IIAP is a deportation rate flow because prior to removal or deportation an illegal immigrant or terrorist must be apprehended and detained prior to deportation. The apprehension rate is based on the percentage of actual illegal immigrants of which some

may be possible terrorists who are caught, and the deportation rate, which has units of population per year, has a deportation delay because sometimes it takes a year or more for an illegal immigrant to be deported.

During a model simulation the apprehension percentage and deportation delay serve as policy levers that may be adjusted to study the impact on the PAIIP model base case's stocks and flows. The Apprehension Rate, AR, has one policy lever, entitled apprehension percentage. The Deportation Rate has one policy lever entitled deportation delay. The unit of the deportation delay is year(s).

The driving mechanisms behind the PAIIP model's cases are feedback loops. For the Detention and Deportation base case the nature of the loops will be explained. There are two balancing loops and one reinforcing loop. The first loop is a balancing loop which is labeled on the model as Depletion of PIIP. As the PIIP increases, the BCR increases; as the BCR increases, the PIIP decreases. The second loop is a reinforcing loop entitled Increase in AIIP. As the AIIP increases, the BCR increases; as the BCR increases the AIIP increases. The third loop is a reinforcing loop, entitled Depletion of AIIP. As AIIP increases, AR increases. As AR increases, AIIP decreases. These three loops are the driving force of the base and extended cases. Other notable feedback elements in the Detention and Deportation model are the AR which feeds into DR, and the IIAP which feeds back into PIIP via the deportation rate.

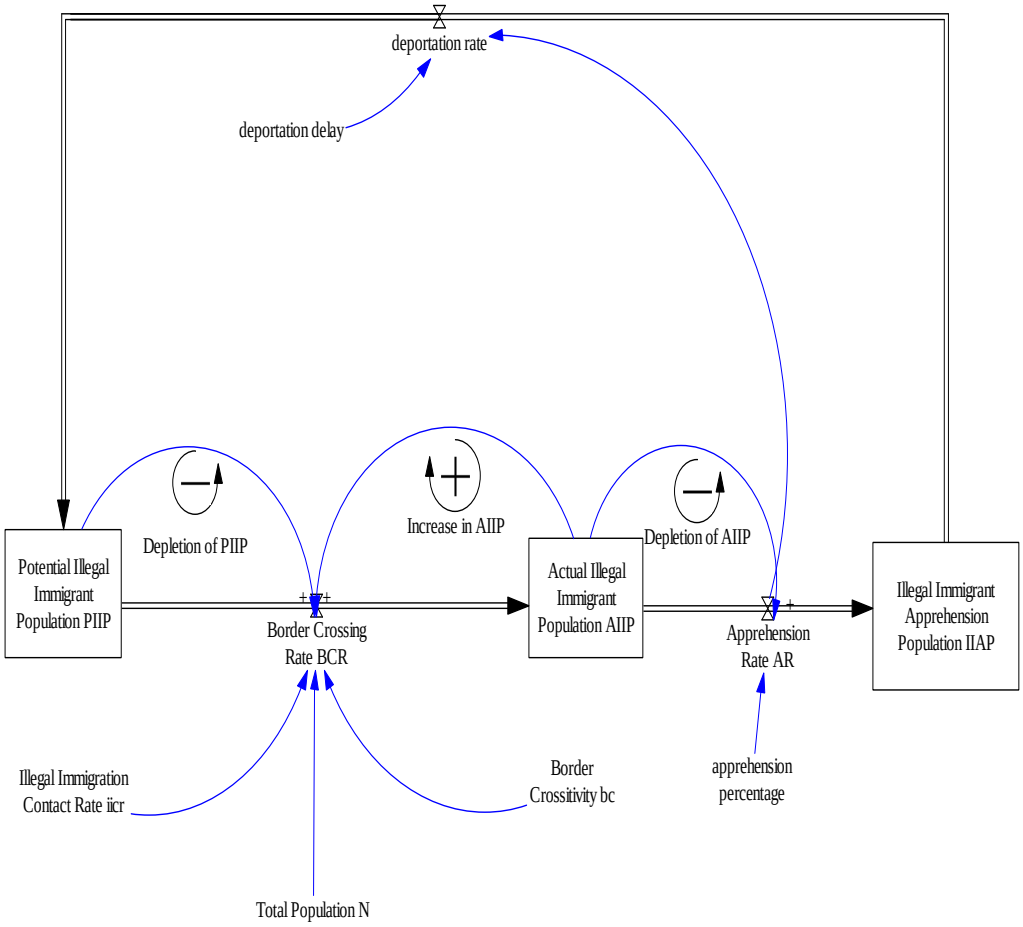
The feedback loops in the PAIIP model's base case support the arguments stated in CLD 1 and CLD 2. Based on the values inputted into the variables of the PAIIP model's cases, the results produced reveal how the content of information communicated between actual and potential illegal immigrants stimulates illegal immigration and is

affected by public policies. Therefore, the slightest change in the value of one stock or policy lever changes the dynamic and behavior of the stocks and rates of the PAIIP model. For example, increasing or decreasing the apprehension percentage affects all of the population stocks and rates. Thus, many simulations with various variable inputs were run for the base case.

PAIIP Model
Base Case #1: Detention and Deportation

Variable	**Type**	**Units**
Potential Illegal Immigrant Population (PAIIP)	Stock	Population
Actual Illegal Immigrant Population (AIIP)	Stock	Population
Illegal Immigrant Apprehension Population (IIAP)	Stock	Population
Border Crossing Rate (BCR)	Flow	Population per year
Apprehension Rate (AR)	Flow	Population per year
Deportation Rate (DR)	Flow	Population per year
Illegal Immigration Contact Rate (iicr)	Policy Lever	Population per year
Total Population (N)	Policy Lever	Population
Border Crossivity (bc)	Policy Lever	Percentage
Apprehension Percentage	Policy Lever	Percentage
Deportation Delay	Policy Lever	Year(s)

Base Case #1: Detention and Deportation

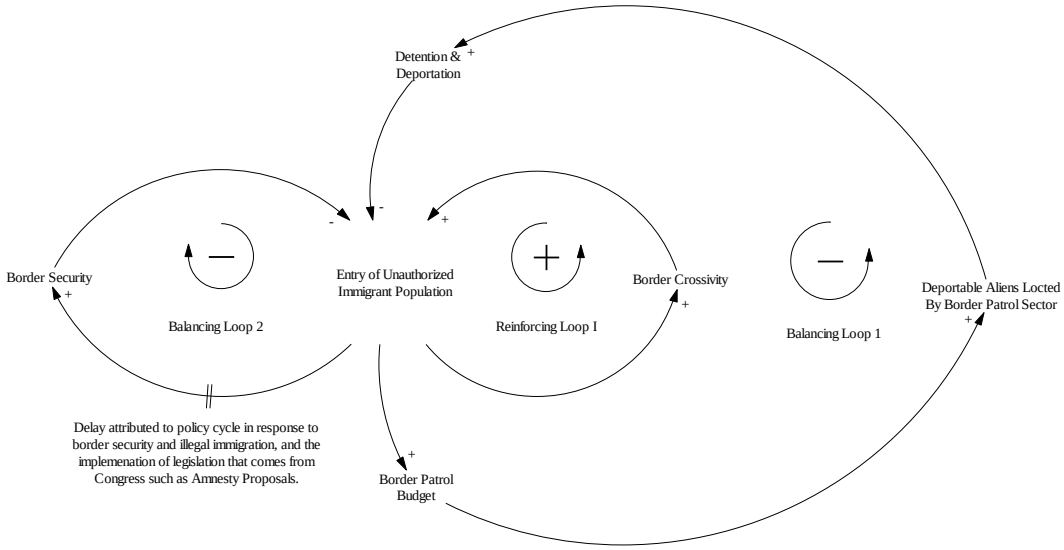


IV.3.2 Detention and Deportation with Amnesty Building Block Model Description (BBM)

The second case is Detention and Deportation with Amnesty. Adding the policy of amnesty in this case flows right into the argument expressed in CLD 3. The amnesty rate flow variable, amnesty percentage policy lever, and Amnesty Population (AP) stock were added to assess their impact on the content of communication between potential and actual illegal immigrants as well as the border crossing rate. In addition, the border crossivity due to AP (Amnesty Population) was set from a range of 0 to 10%. The

concept behind the border crossivity due to AP parameter is that as the amnesty population increases, the border crossivity variable should increase because word would be spreading that the United States is granting amnesty to illegal immigrants. Likewise, as the Amnesty Population decreases, the border crossivity parameter should decrease.

Causal Loop Diagram 3

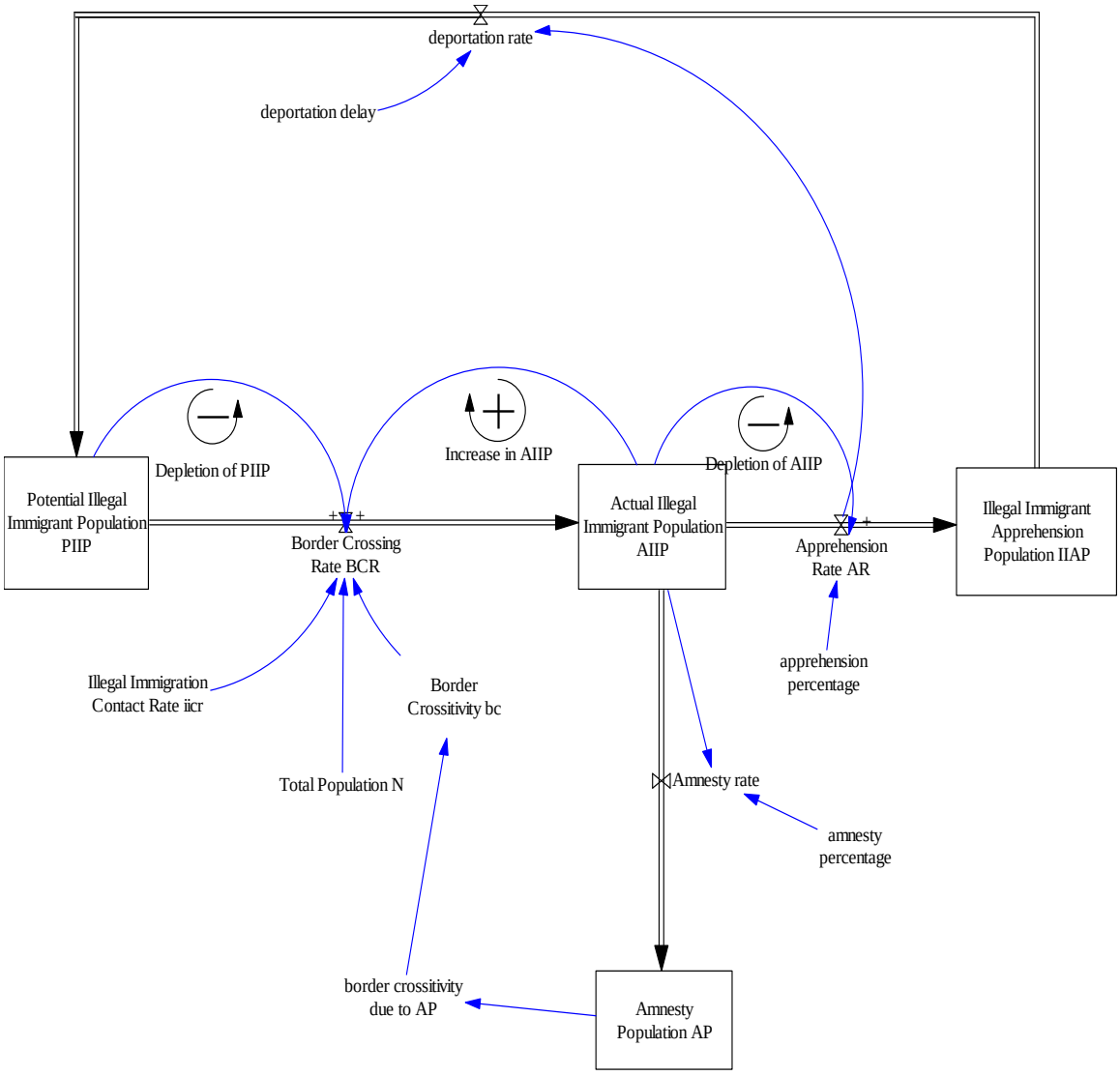


The AP has units of population. Like the other three population stock variables, the AP's initial value may be set by the policy actor. Out of the AIIP stock is an Amnesty rate flow variable which has units of population per year. The amnesty rate is calculated by the PAIIP model, but it is directly influenced by the amnesty percentage policy lever that it is connected to it. The amnesty percentage is inputted by the policy actor between the values of 0 to 100%. The amnesty rate flows into the AP stock. The border crossivity due to AP feeds back into the border crossivity variable which feeds back into the BCR.

PAIIP Model
Case #2: Amnesty with Deportation

Variable	Type	Units
Potential Illegal Immigrant Population (PAIIP)	Stock	Population
Actual Illegal Immigrant Population (AIIP)	Stock	Population
Illegal Immigrant Apprehension Population (IIAP)	Stock	Population
Amnesty Population (AP)	Stock	Population
Border Crossing Rate (BCR)	Flow	Population per year
Amnesty rate	Flow	Population per year
Apprehension Rate (AR)	Flow	Population per year
Deportation Rate (DR)	Flow	Population per year
Illegal Immigration Contact Rate (iicr)	Policy Lever	Population per year
Total Population (N)	Policy Lever	Population
Border Crossivity (bc)	Policy Lever	Percentage
Apprehension Percentage	Policy Lever	Percentage
Amnesty Percentage	Policy Lever	Percentage
Border crossivity due to AP	Feedback Parameter	Percentage
Deportation Delay	Policy Lever	Year(s)

Case #2: Amnesty with Deportation



V. Findings

The expectations for each Potential Actual Illegal Immigration (PAIIP) model case are articulated in this section. Next, the validation process for the PAIIP model is presented. Finally, the results from the validation are recorded and discussed. The quantitative data and trends discussed in this section help provide a framework of support towards exploring solution(s) for border security and illegal immigration.

V.1 Expectations

The following expectations for the simulation results from the PAIIP model's cases are derived from the causal loop diagrams (CLD 1 – 3) presented in this study.

1. An increase in the value of the border crossivity policy lever should increase:
    a) the Potential Illegal Immigrant Population
    b) the entry of unauthorized immigrants (border crossing rate), and
    c) the Actual Illegal Immigrant Population
2. A decrease in the value of the border crossivity policy lever should decrease:
    a) the Potential Illegal Immigrant Population
    b) the entry of unauthorized immigrants (border crossing rate), and
    c) the Actual Illegal Immigrant Population
3. An increase in the value of the illegal immigration contact rate (iicr) should increase:
    a) the entry of unauthorized immigrants (border crossing rate), and
    b) the Actual Illegal Immigrant Population

4. A decrease in the value of the illegal immigration contact rate (iicr) should decrease:
    a) the entry of unauthorized immigrants (border crossing rate), and
    b) the Actual Illegal Immigrant Population
5. An increase in the apprehension percentage (Deportable Aliens Located By Border Patrol Sector) should decrease:
    a) the Actual Illegal Immigrant Population, and
    b) the entry of unauthorized immigrants (border crossing rate)
6. An increase in the apprehension percentage (Deportable Aliens Located By Border Patrol Sector) should increase:
    a) detentions (Illegal Immigrant Apprehension Population) and,
    b) deportations (deportation rate)
7. A decrease in the apprehension percentage (Deportable Aliens Located By Border Patrol Sector) should increase:
    a) the entry of unauthorized immigrants (border crossing rate), and
    b) the Actual Illegal Immigrant Population
8. An increase in the amnesty percentage should increase:
    a) the Amnesty Population (AP) and,
    b) the value of the border crossivity variable
9. A decrease in the amnesty percentage should decrease:
    a) the Amnesty Population (AP) and,
    b) the value of the border crossivity variable

The expectations described in this section set up a framework for further discussion of the PAIIP model's case results. Moreover, comparing and contrasting the PAIIP model's two cases in the following subsections will be extremely insightful because they incorporate past and present policies that have been used to regulate border security and illegal immigration.

V.2 PAIIP Model Validation

The purpose of this section is to examine the behavior of both cases for the PAIIP model prior to providing its simulation results. The data used to validate the PAIIP model's behavior and results are theoretical.

The following tables provide the theoretical data that was calculated and inputted into the PAIIP model's Detention and Deportation case simulations:

Parameters (Theoretical) Inputted for (All) Simulations

PIIP	AIIP	IIAP	N
99	1	Calculated by PAIIP Model	100

Parameters (Theoretical) Inputted for (All) Simulations

Border Crossing Rate	Apprehension Rate	Deportation Rate
Calculated by PAIIP Model	Calculated by PAIIP Model	Calculated by PAIIP Model

Simulation #	IICR	Border Crossivity	Apprehension %	Deportation Delay
1	1	20%	35%	1 year
2	2	40%	35%	2 years
3	3	60%	35%	3 years
4	4	80%	35%	4 years
5	5	100%	35%	5 years

For the Detention and Deportation model, Simulation numbers (1 – 5) increased the iicr, border crossivity, and deportation delay policy levers. The focus behind these five simulations was on the process of communication and contact between actual and potential illegal immigrants by simulating border crossings when the initial actual

population of illegal immigrants is 1, and the potential illegal immigration population is 99. The total population communicating with each other is 100.

With border crossivity set at 20% and the iicr set to 1 for Simulation number 1 of the Detention and Deportation case, Chart 1 shows the results for the PIIP, AIIP, and IIAP; Chart 2 shows the results for the BCR, AR, and DR. The changes in the PIIP, AIIP, and IIAP are very minute and are almost negligible because their value changes are on a decimal level. These miniscule changes are reflective in the BCR, AR, and DR as well.

Chart 1

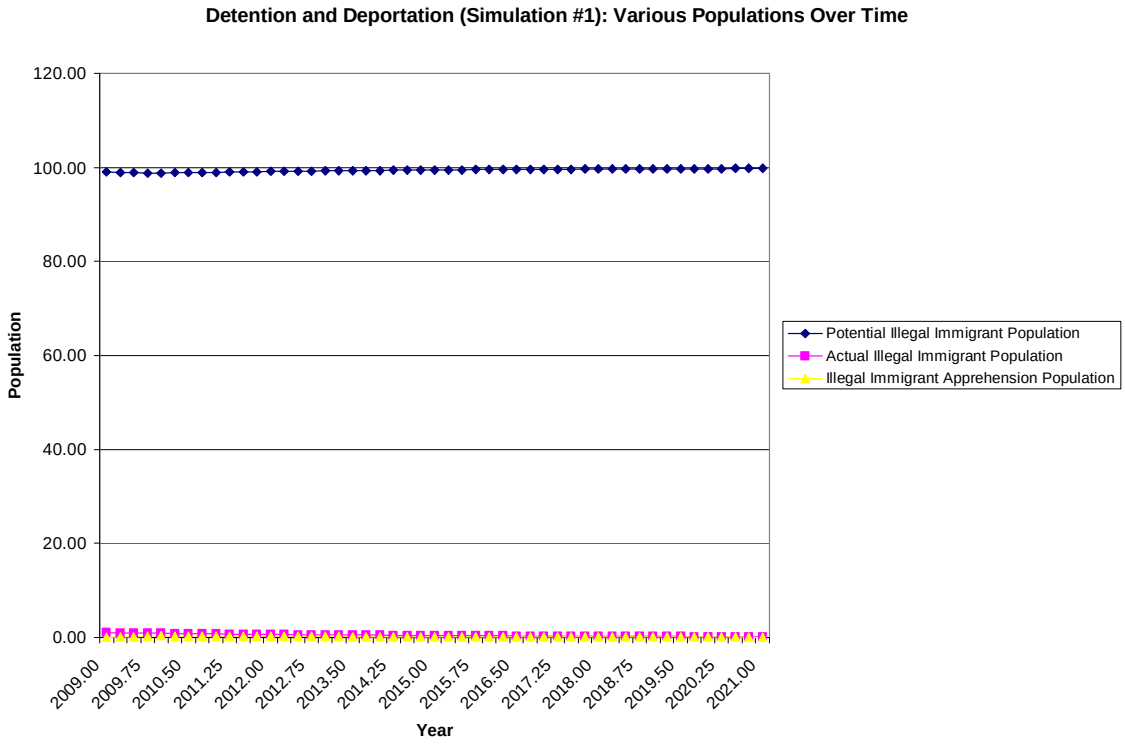


Chart 2

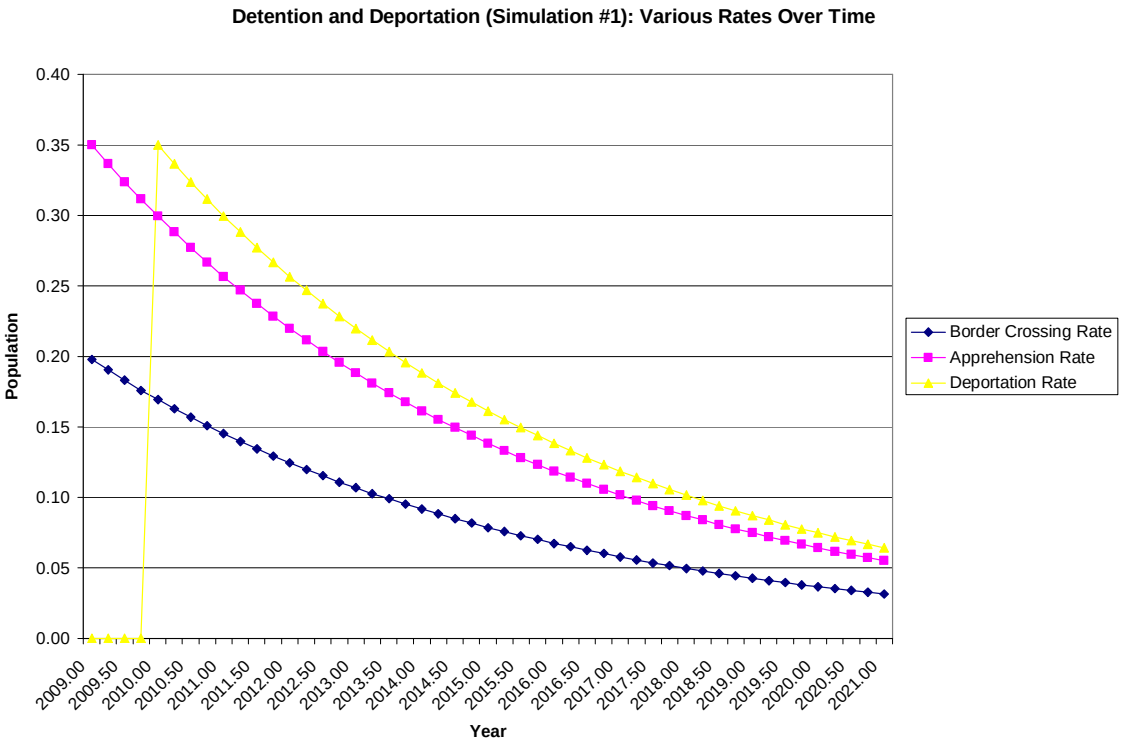


Chart 3 and Chart 4 reveal the results when the border crossivity's value was increased to 40% and the iicr was set to 2 for Simulation number 2. Increasing the border crossivity and the iicr produced visible growth and changes in the various populations and rates for the Detention and Deportation case. While the PIIP decreases, both the AIIP and IIAP increase. The increase in communication and contact rate resulted in increases for the BCR, AR, and DR.

Chart 3

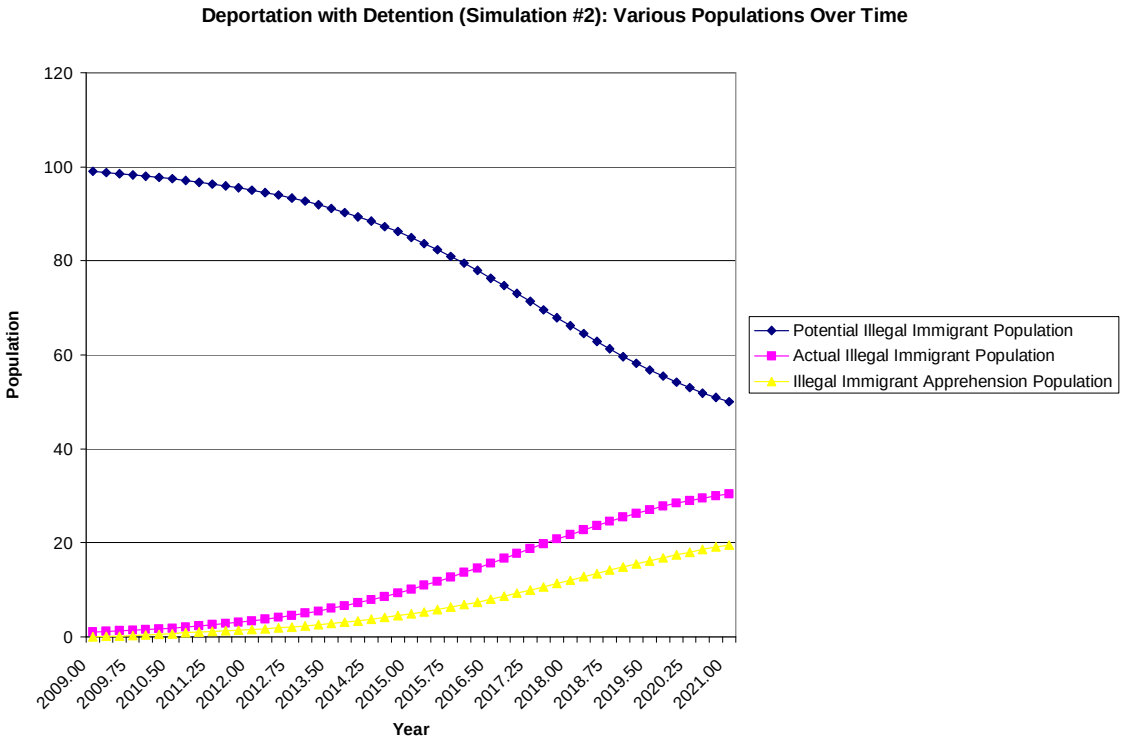
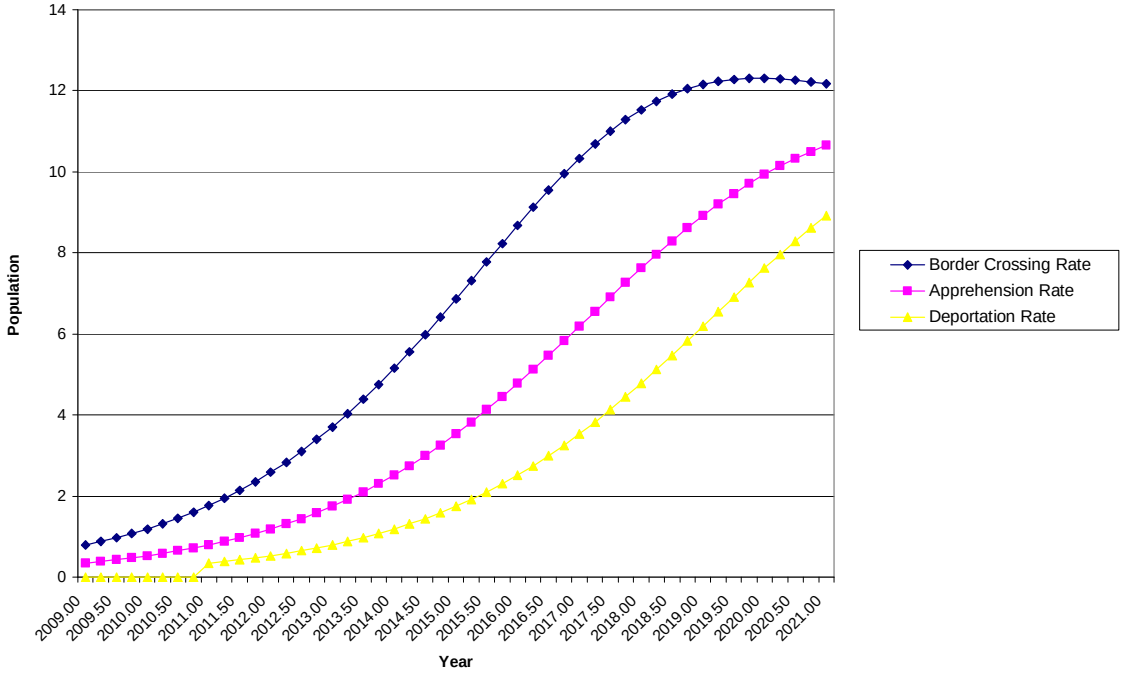


Chart 4



The border crossivity value was set to 60% and the iicr was increased to 3, for Simulation number 3, and the results are presented in Chart 5 and Chart 6. The increased border crossivity and contact rate creates more dynamics in the PIIP, AIIP, and IIAP. First, there is a faster and sharper initial decrease in the PIIP from the years 2009 to 2015. Then, from 2015 to 2018, the PIIP increases, and from 2018 to 2021, the PIIP decreases.

Between the years of 2009 and 2021, both the AIIP and IIAP exponentially increase for some time, then decrease, and slightly increase again. The AIIP increases from the years of 2009 to 2013.75; then it decreases from 2014 to 2018.75 before slightly increasing again and leveling off from 2019 to 2021. The IIAP increases from the years 2009 to 2016, then it decreases from 2016.25 to 2019 before increasing again and leveling off between 2019.25 and 2021.

Chart 5

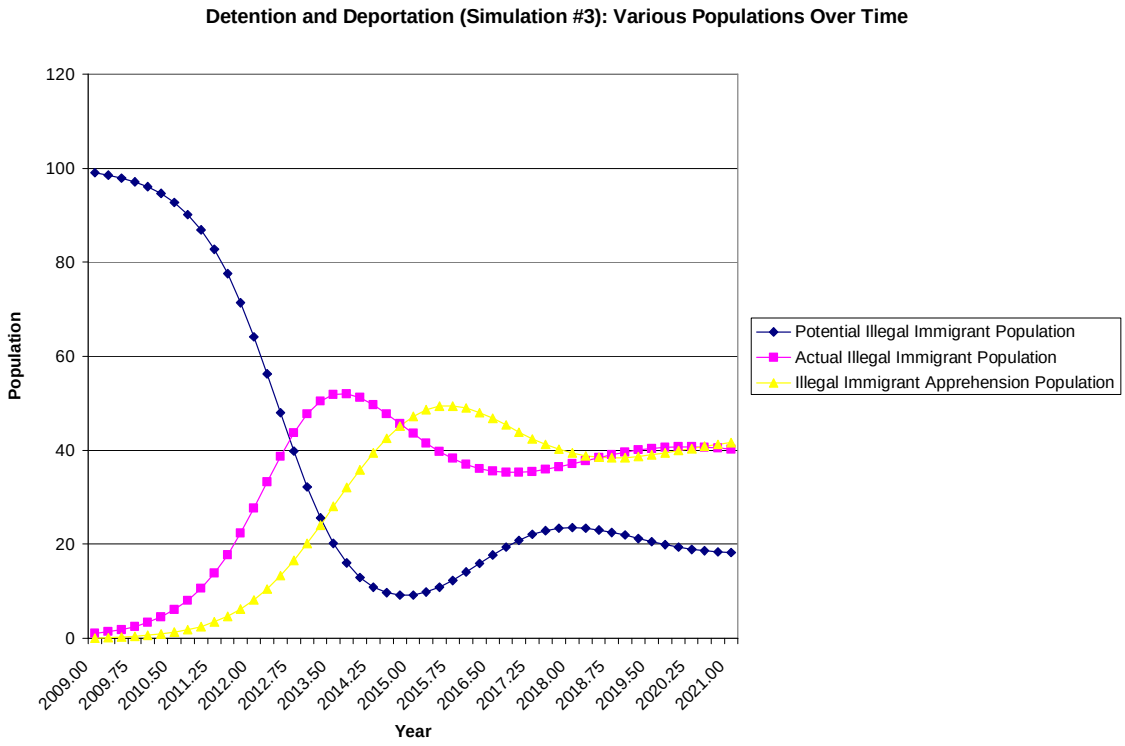
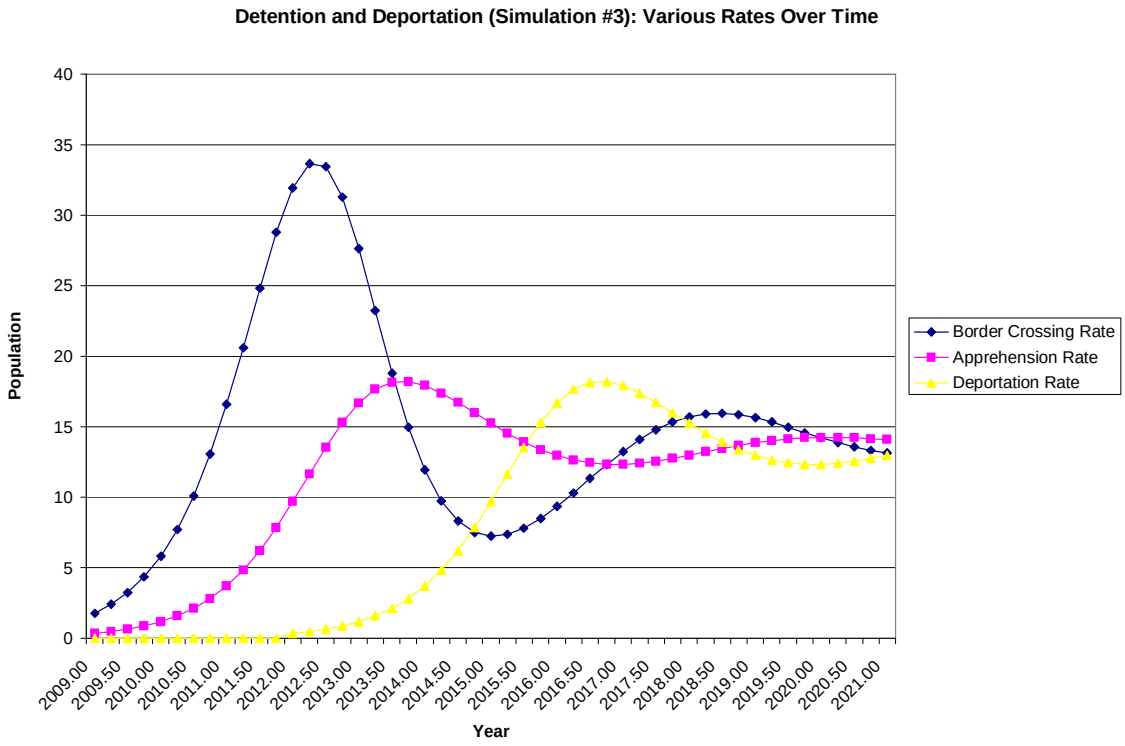


Chart 6 also delineates how the increase in border crossivity and iicr in Simulation number 3 produced more activity in the BCR, AR, and DR. Each rate overshoots and collapses until finally converging between a value of either 13 or 14 people per year. Though the behavior of each rate is analogous, the largest initial increase is in the BCR. For example, the border crossing rate increases from 2 people a year in 2009 to over 30 people a year by 2012.

Chart 6



Simulation number 4 increased the border crossivity and iicr to 80% and 4 people a year respectively. The results from Simulation number 4 are illustrated in Chart 7 and Chart 8. Simulation number 5 increases the border crossivity to 100%. The border crossivity in Simulation number 5 was increased to 100%, and the iicr was increased to 5; Chart 9 and Chart 10 show the results.

Chart 7

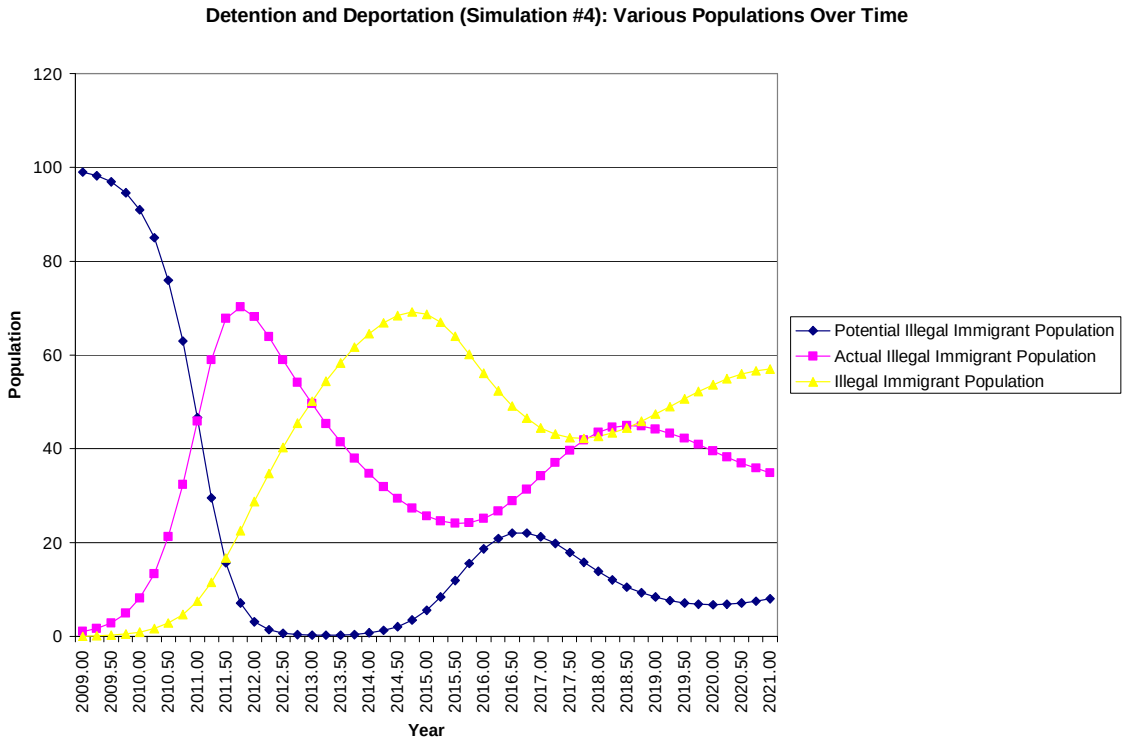


Chart 8

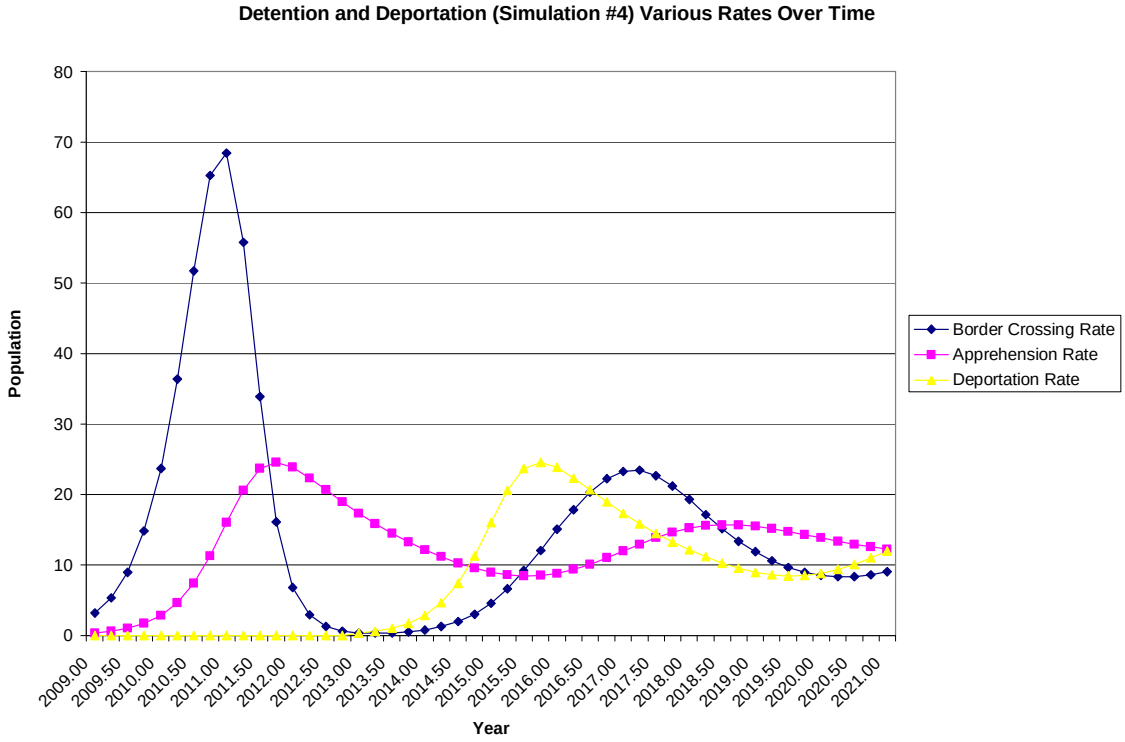


Chart 9

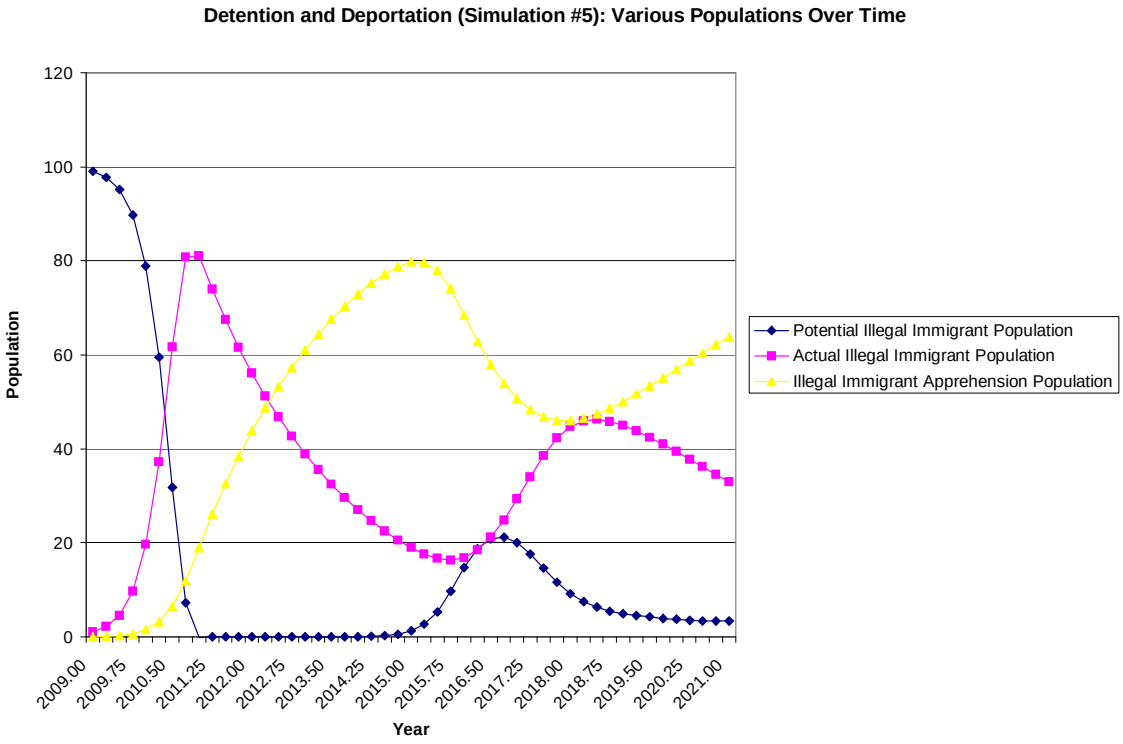
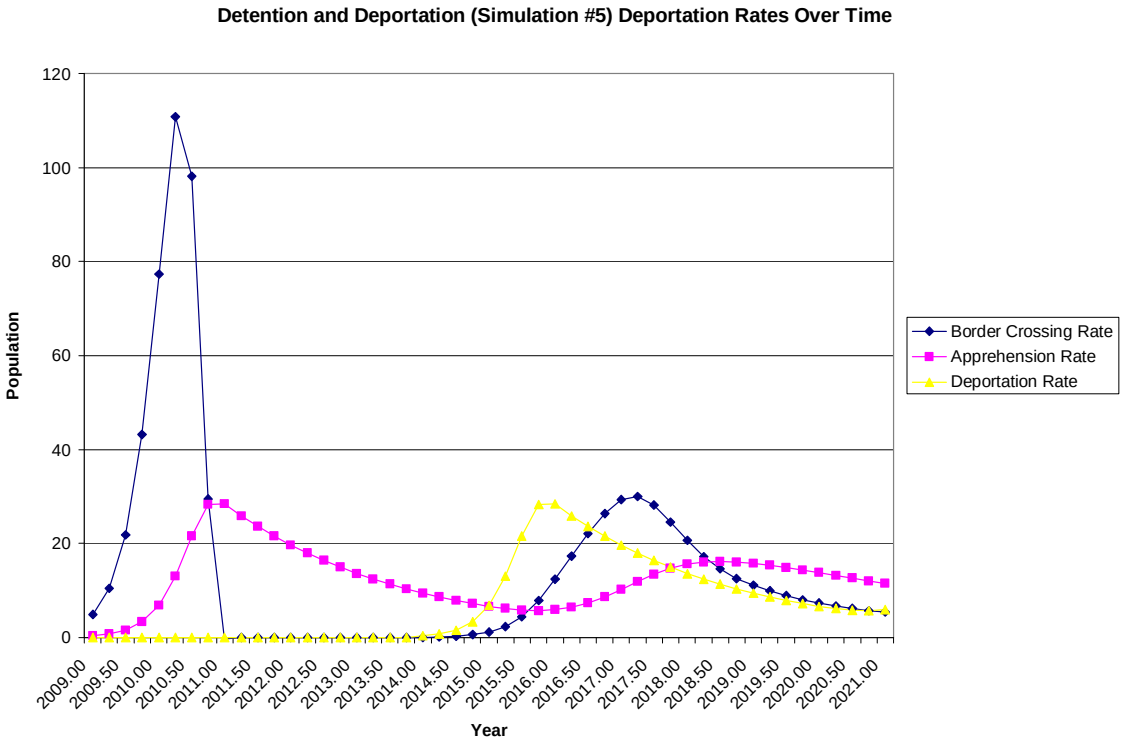


Chart 10



The results from the Detention and Deportation simulation numbers (1 - 5) reveal that increasing both border crossivity and the iicr increases illegal border crossings. Increasing border crossivity results in a significant initial surge in illegal crossings. However, as illegal immigrants cross the border and are apprehended and deported the actual illegal immigration and apprehension population both increase and decrease over time. The apprehended and deported aliens feed into the potential illegal immigrant population. The potential illegal immigrant population is drained when there is a successful border crossing. This entire process of activities and behaviors creates the various graphical results depicted in the simulation charts for the Detention and Deportation case.

In continuation of the validation of the PAIIP model, the focus will now shift towards the Detention and Deportation with Amnesty case. For the Detention and Deportation with Amnesty model, Simulation numbers (1 – 5) increase the iicr, border crossivity, deportation delay, and amnesty policy levers, while the apprehension rate remains constant. The purpose behind these five simulations is to examine the process of communication and contact between actual and potential illegal immigrants by simulating border crossings, when the initial actual population of illegal immigrants is 1 and the potential illegal immigration population is 99, and to examine how the additional policy of amnesty in this case impacts communication and contact. The total population communicating with each other is 100.

The results for the Detention and Deportation with Amnesty case are recorded in Charts 11-20; and the data collected will be compared to the results of the Deportation with Detention case, specifically Charts (1 – 10) in this section. The same data used for the base case was inputted into this case to examine the impact of adding an amnesty rate and amnesty population stock.

In comparing Simulation number 1 for both cases, Chart 1 and Chart 11 exhibit the same behavior; both charts show little to no change in their respective populations. Also, for Simulation number 1, Chart 2 and Chart 12 demonstrate how the respective rates for each case show very minute changes in value. As the border crossivity and iicr are increased, the dynamics of the second case's results initially change, but the majority of data graphed behave similarly to the base case's results. For example, although the potential illegal immigrant population in Chart 13 decreases over time, the amnesty population exponentially increases in Chart 13. The increase in the amnesty population over time causes a slower growth in the actual illegal immigrant and illegal immigrant apprehension populations. As depicted in Chart 14, every rate exponentially increases, reaches a maximum, and then begins to decrease.

The remaining Charts (15 – 20) all show that an increase in border crossivity and the iicr for the PAIIP model's second case causes an exponential increase in the amnesty population. In addition, in Charts (15, 17, and 19), the potential illegal immigrant population exponentially decreases and afterwards increases before leveling off. Moreover, as illegal immigrants are apprehended and deported, the actual and illegal immigrant apprehension populations overshoot and collapse for Charts (15, 17, and 19).

Finally, the border crossing, apprehension, deportation, and amnesty rates for Charts (16, 18, and 20), all overshoot and collapse.

The results from the second case reveal a flaw in the PAIIP model. For instance, in Simulation number 5, the total population is 100 (Actual Illegal immigrants = 1, and Potential Illegal Immigrants = 99) and the various stocks throughout the model are drained by different rates; Chart 20 demonstrates how the border crossing rate decreases below zero to negative values. This behavior indicates that the PAIIP model is not perfect. Thus, the user must be conscious about the data inputted into the model, especially small population values for the PIIP and AIIP as the border crossivity and iicr are increased.

The following tables provide the theoretical data that was calculated and inputted into the PAIIP model's Detention and Deportation with Amnesty case simulations:

Parameters (Theoretical) Inputted for (All) Simulations

PIIP	AIIP	IIAP	N
99	1	Calculated by PAIIP Model	100

Parameters (Theoretical) Inputted for (All) Simulations

AP	Border Crossing Rate	Apprehension Rate
0	Calculated by PAIIP Model	Calculated by PAIIP Model

Parameters (Theoretical) Inputted for (All) Simulations

Amnesty Rate	Deportation Rate	Apprehension %
Calculated by PAIIP Model	Calculated by PAIIP Model	35%

Simulation #	IICR	Border Crossivity	Amnesty Percentage	Deportation Delay
1	1	20%	20%	1 year
2	2	40%	40%	2 years
3	3	60%	60%	3 years
4	4	80%	80%	4 years
5	5	100%	100%	5 years

Chart 11

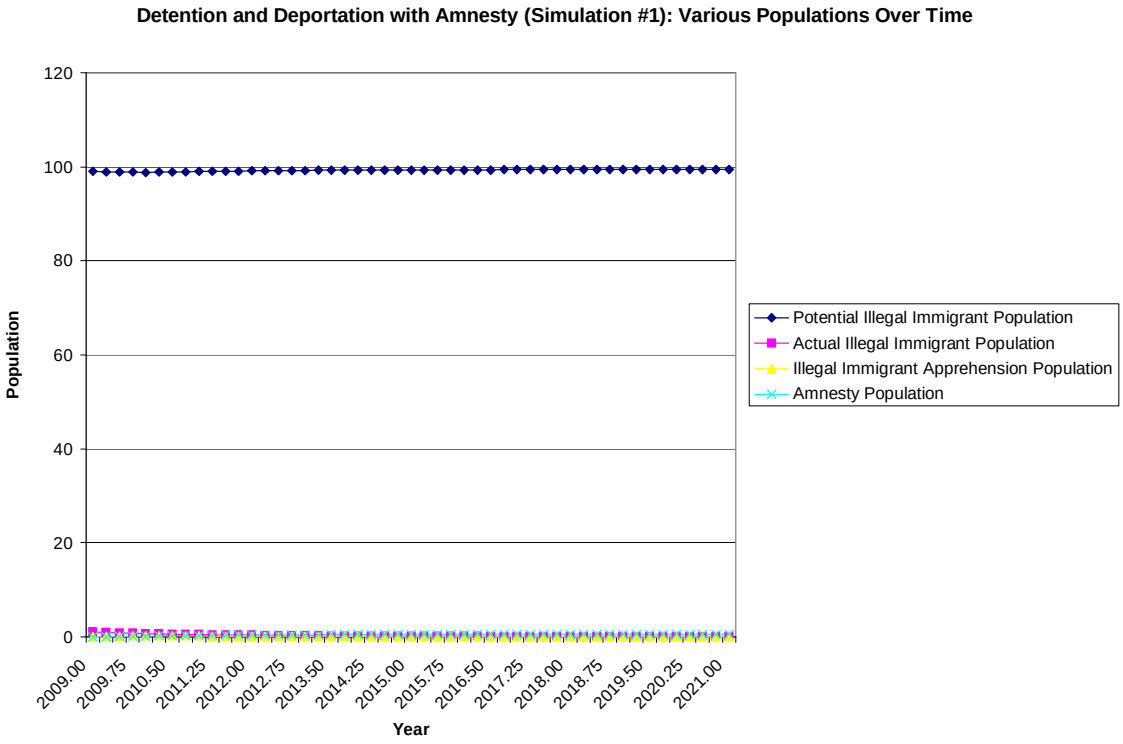


Chart 12

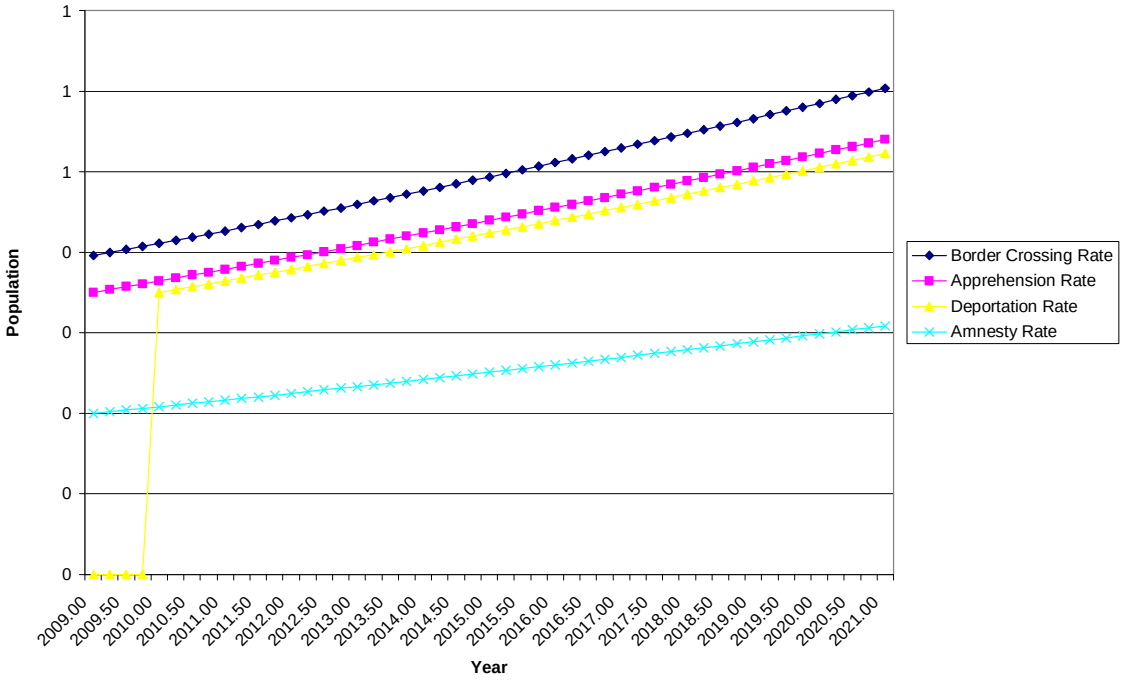


Chart 13

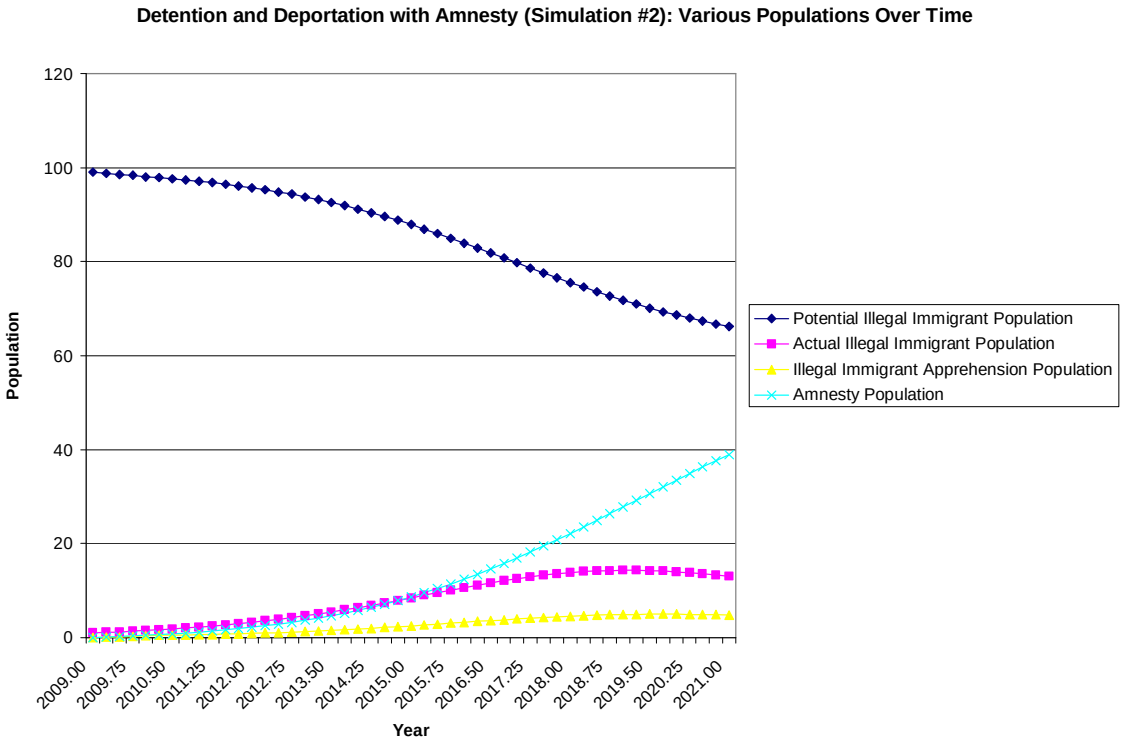


Chart 14

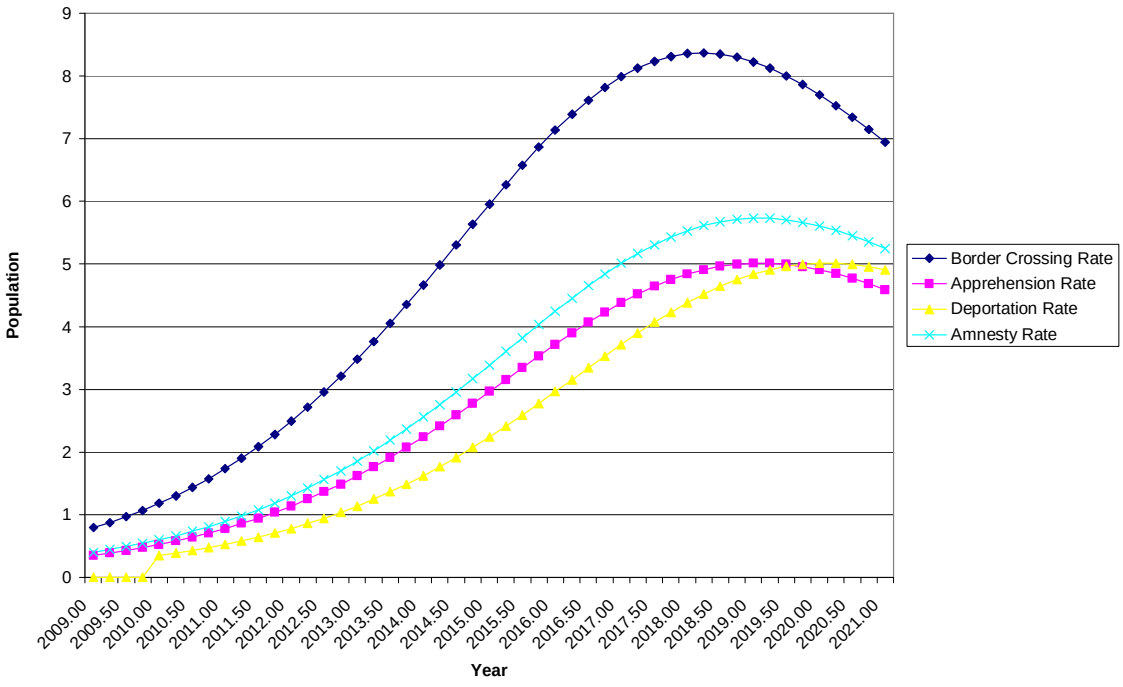


Chart 15

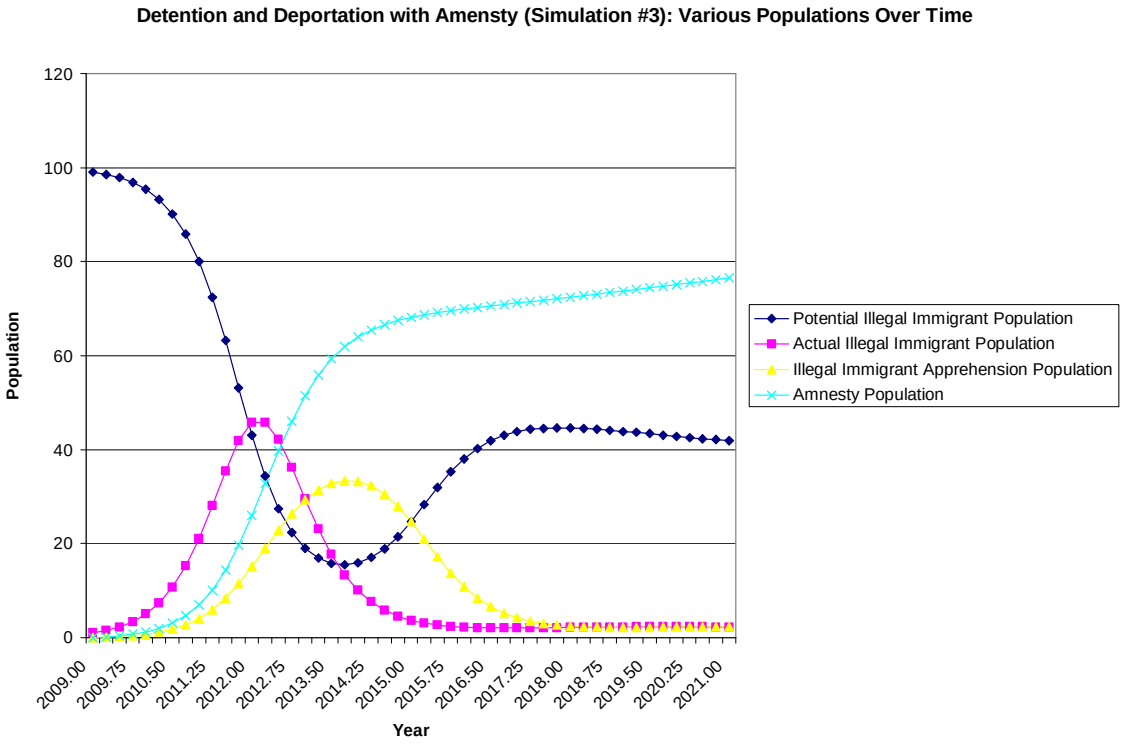


Chart 16

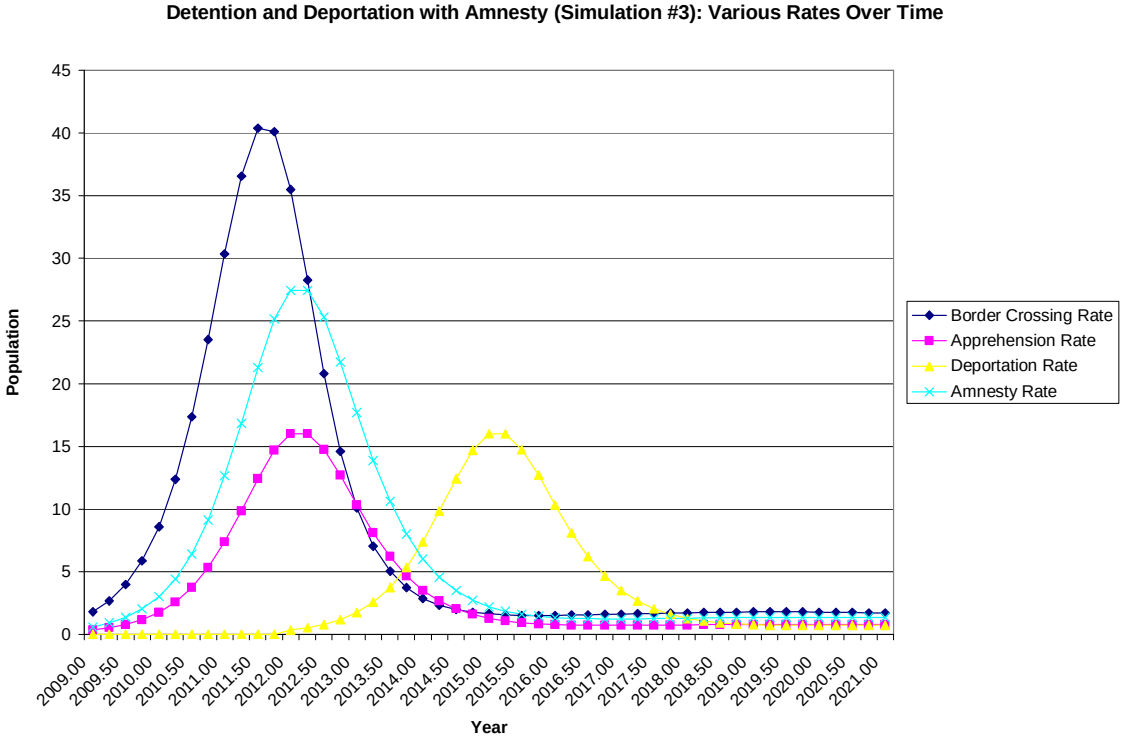


Chart 17

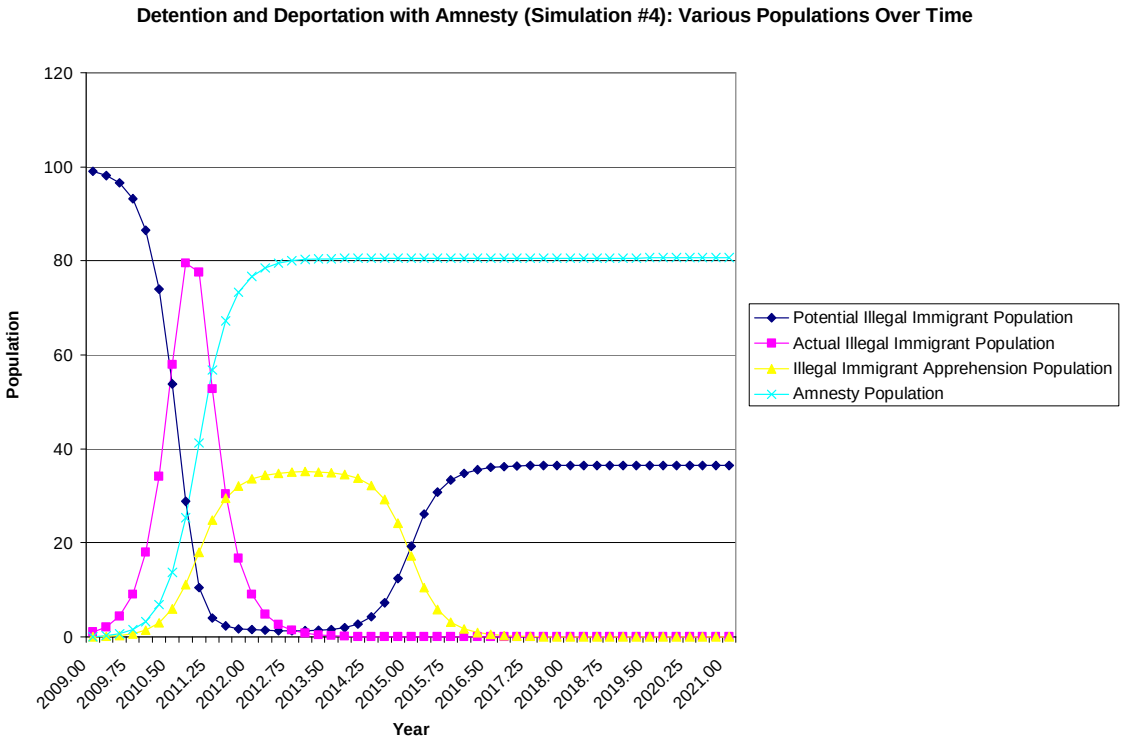


Chart 18

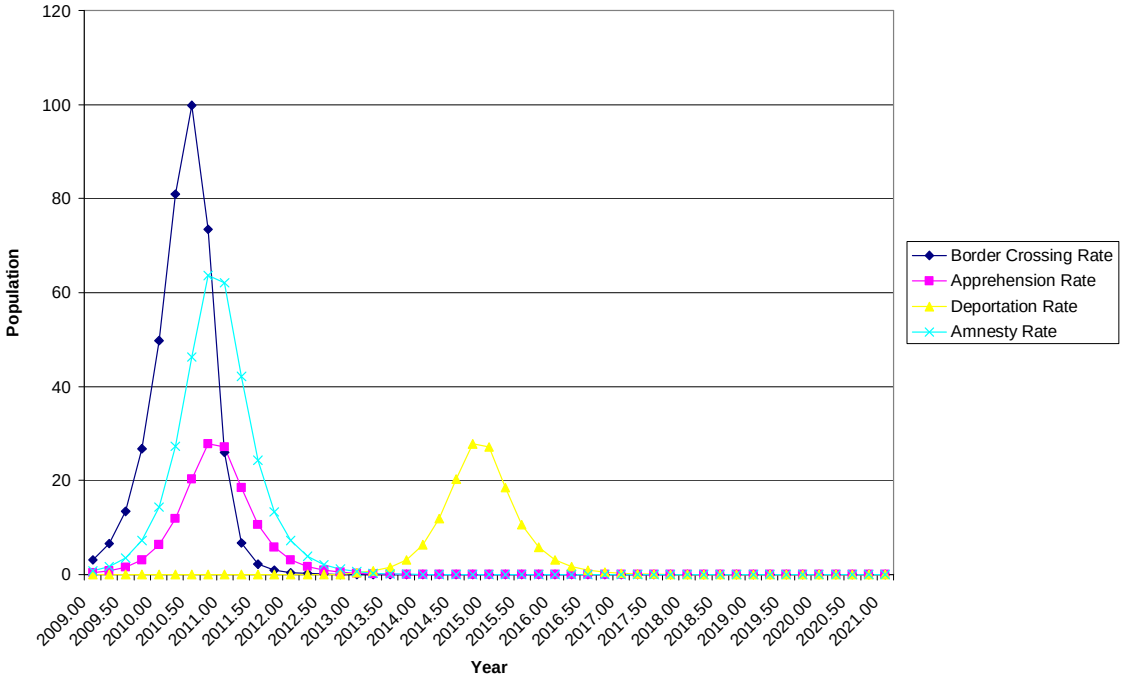


Chart 19

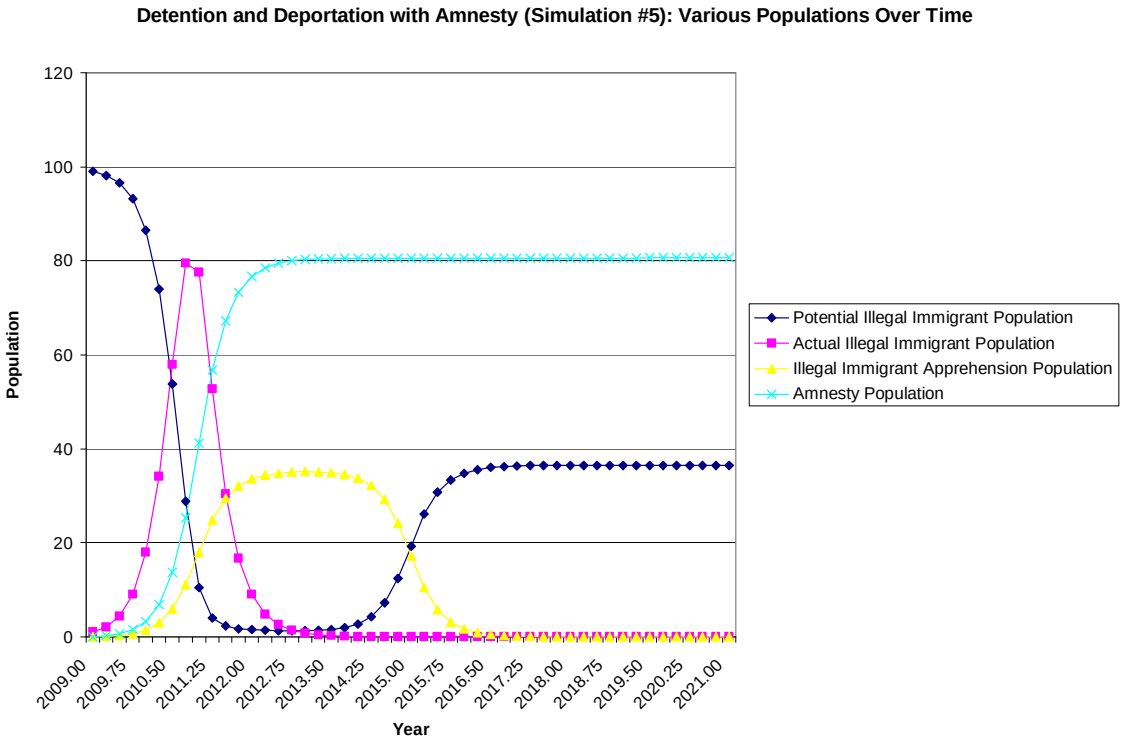
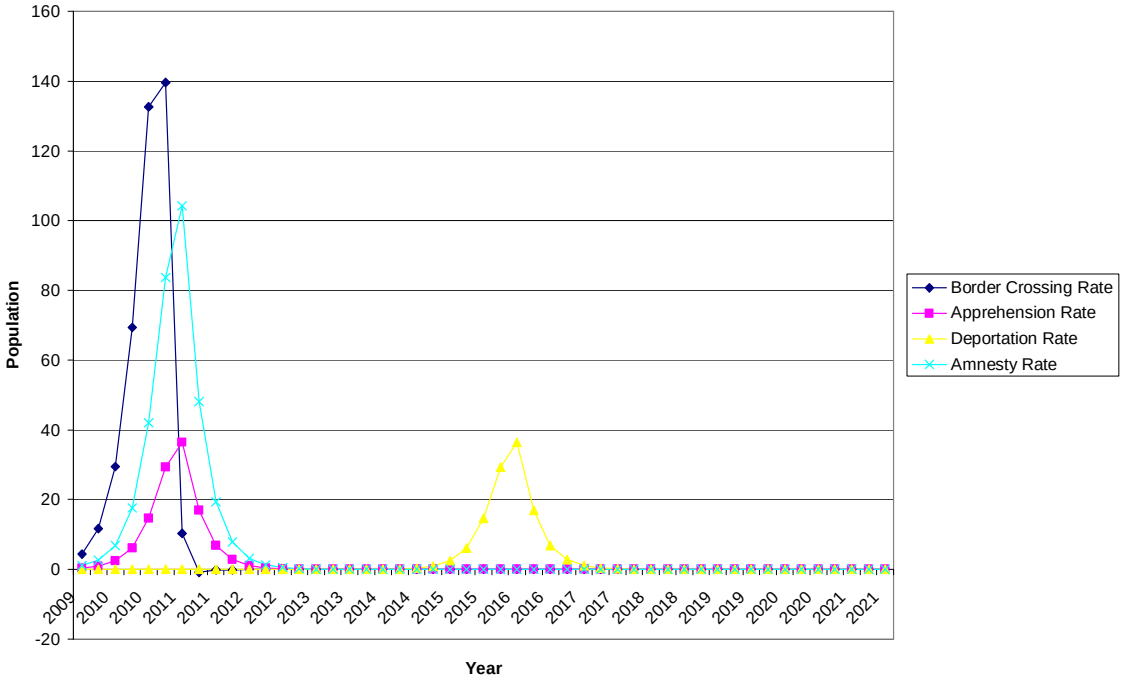


Chart 20



VI. Discussion

The research in this study encompasses the utilization of systems modeling to examine and aid towards solving some of the problems of border security and illegal immigration. Therefore, the context of the discussion will show the success of the PAIIP model, elaborate on the dynamics and implications of the PAIIP model's results, and answer the questions raised in the research questions section. In doing so, the foundation from the discussion section on the PAIIP Model will be used to make policy recommendation(s).

VI.1 Results

The results from the Detention and Deportation and Detention and Deportation with Amnesty cases will be elaborated upon even further. The purpose of this section is to ascertain how the policies of detention and deportation and amnesty impact the communication between potential and actual illegal immigrants.

VI.1.1 Detention and Deportation

Fifty simulations were run for the Deportation with Detention case. For each respective illegal immigration contact rate (1-5), the border crossivity and apprehension percentages were incrementally increased by 10%, while the deportation delay was kept constant at one year. Hence, more theoretical data was inputted into the PAIIP model to examine and discuss the impact of detention and deportation on a larger total population of 60 million potential and actual illegal immigrants communicating with each other.

The charts in this section display the results for each variable in this case, when the border crossivity variable was set to 10% and 100% respectively. Charts (1 – 6) provide the results on communication between potential and actual illegal immigrants when the border crossivity is 10%. Charts (7-12) demonstrate the results when the border crossivity is 100%. The remaining charts for the base case are located in Appendix B.

Charts (1-3) and Charts (7-9) present the results for the various population variables from the Detention and Deportation case. Chart 1 and Chart 7 show the growth in the potential illegal immigrant population. As the iicr was increased from (1 -5) people a year, the overall potential illegal immigrant population decreased for Chart 1 and Chart 7 for each respective contact rate. Since the border crossivity is ten times higher for Chart 7's results than Chart 1's, the potential illegal immigrant populations are greater for Chart 7. Moreover, Chart 1's trends for its various potential illegal immigrant populations steadily decrease faster than Chart 7's. Though the potential illegal immigrant population decreases in Chart 7, the high level of communication causes the growth for each population and respective contact rate to level off.

Chart 2 and Chart 8 show the growth in the actual illegal immigrant population. The actual illegal immigrant population increased for each respective contact rate for both charts. Even though the overall actual illegal immigrant population increased for both charts, Chart 8's trends in growth for its populations vary from Chart 2. For instance, while Chart 2 shows exponential growth for each actual illegal immigrant population, Chart 8's results yield more dynamic growth patterns such as overshooting and collapsing. The difference in Chart 2 and Chart 8's behavior is attributed to the value of the apprehension percentage(s) for the results in both charts. Chart 2's apprehension

percentage is 10%, while Chart 8's apprehension percentage is a maximum value of 100%. The higher the apprehension percentage the faster the actual illegal immigrant population is drained across each respective contact rate.

Chart 3 and Chart 9 show the behavior of the illegal immigrant population. The illegal immigrant apprehension population increased for the respective contact rate for both charts. Although both charts display an increase in the overall illegal immigrant apprehension population, Chart 9 displays higher values and more dynamics in its growth trends for apprehended illegal immigrants than Chart 3. While Chart 3 demonstrates linear and exponential growth, Chart 9's trends in growth exponentially decrease, increase, or overshoot and collapse. Chart 9's trends are attributed to the maximum apprehension percentage of 100% and the combined deportation rate and deportation delay of one year. Thus, as apprehensions feed into the illegal immigrant apprehension population, at the same time it is also drained by the deportation rate.

Charts (4-6) and Charts (10-12) show the results for the various rates in the base case. Chart 4 and Chart 10 show the growth in the border crossing rate. As the iicr was increased from (1-5) people a year, the overall border crossing rate increased for Chart 4 and Chart 10. When the iicr was set to 1 the border crossing rates for Chart 4 and Chart 10 decreased; Chart 4's decrease was linear, while Chart 10's was exponential. Chart 4's trends produced linear growth when the iicr was set to 2 and exponential growth when the iicr was set to 3; iicr values of 4 and 5 produced trends that overshot and collapsed. Chart 10's border crossing rate trend overshot and collapsed when the iicr was set to 2; iicr values of 3, 4, and 5 resulted in oscillation.

The overall behavior for the border crossing rates in Chart 10 varies from Chart 4 and is more dynamic because the border crossivity was greater in value. In addition, since the potential and actual illegal immigrant populations increased due to successful illegal border crossings and decreased from apprehensions and deportations, the total population of communication fluctuated as well. Thus, as the iicr increased, the growth trends in the border crossing rate displayed greater variation.

Chart 5 and Chart 11 show the growth in the apprehension rate. Except for the decreasing trend when the iicr was set to 1 for Chart 5 and Chart 11, the overall apprehension rate for the remaining contact rate values increased for both charts. However, Chart 5's trends in growth for its apprehension rate vary from Chart 11. For instance, while Chart 5 shows linear and exponential growth in the apprehension rate for iicr values ranging from 2 to 5, Chart 8's results yield more dynamic growth patterns, especially oscillation. The difference in Chart 5 and Chart 11's behavior is attributed to the apprehension percentages of 10% and 100% respectively, as well as the discrepancy in growth for their actual illegal immigrant population(s).

Chart 6 and Chart 12 show the behavior of the deportation rate. The overall deportation rate for each respective contact rate value increases for Chart 6 and Chart 12, except for the decreasing trend when the iicr was set to 1 for both charts. While Chart 12's results yield more dynamic growth patterns such as overshooting and collapsing and oscillation, Chart 5 shows linear and exponential growth in the deportation rate. These differences are due to the variation in growth for their illegal immigrant apprehension populations, and the respective apprehension percentage values of 10% and 100%.

The following tables provide the theoretical data that was calculated and inputted into the PAIIP model's Detention and Deportation case simulations:

Parameters (Theoretical) Inputted for (All) Simulations

PIIP	AIIP	IIAP	N
50 million	10 million	Calculated by PAIIP Model	60 million

Parameters (Theoretical) Inputted for (All) Simulations

Border Crossing Rate	Apprehension Rate	Deportation Rate
Calculated by PAIIP Model	Calculated by PAIIP Model	Calculated by PAIIP Model

Simulation #	IICR	Border Crossivity	Apprehension %	Deportation Delay
1	1	10%	10%	1 year
2	1	20%	20%	1 year
3	1	30%	30%	1 year
4	1	40%	40%	1 year
5	1	50%	50%	1 year
6	1	60%	60%	1 year
7	1	70%	70%	1 year
8	1	80%	80%	1 year
9	1	90%	90%	1 year
10	1	100%	100%	1 year

Simulation #	IICR	Border Crossivity	Apprehension %	Deportation Delay
11	2	10%	10%	1 year
12	2	20%	20%	1 year
13	2	30%	30%	1 year
14	2	40%	40%	1 year
15	2	50%	50%	1 year
16	2	60%	60%	1 year
17	2	70%	70%	1 year
18	2	80%	80%	1 year
19	2	90%	90%	1 year
20	2	100%	100%	1 year

Simulation #	IICR	Border Crossivity	Apprehension %	Deportation Delay
21	3	10%	10%	1 year
22	3	20%	20%	1 year
23	3	30%	30%	1 year
24	3	40%	40%	1 year
25	3	50%	50%	1 year
26	3	60%	60%	1 year
27	3	70%	70%	1 year
28	3	80%	80%	1 year
29	3	90%	90%	1 year
30	3	100%	100%	1 year

Simulation #	IICR	Border Crossivity	Apprehension %	Deportation Delay
31	4	10%	10%	1 year
32	4	20%	20%	1 year
33	4	30%	30%	1 year
34	4	40%	40%	1 year
35	4	50%	50%	1 year
36	4	60%	60%	1 year
37	4	70%	70%	1 year
38	4	80%	80%	1 year
39	4	90%	90%	1 year
40	4	100%	100%	1 year

Simulation #	IICR	Border Crossivity	Apprehension %	Deportation Delay
41	5	10%	10%	1 year
42	5	20%	20%	1 year
43	5	30%	30%	1 year
44	5	40%	40%	1 year
45	5	50%	50%	1 year
46	5	60%	60%	1 year
47	5	70%	70%	1 year
48	5	80%	80%	1 year
49	5	90%	90%	1 year
50	5	100%	100%	1 year

Chart 1

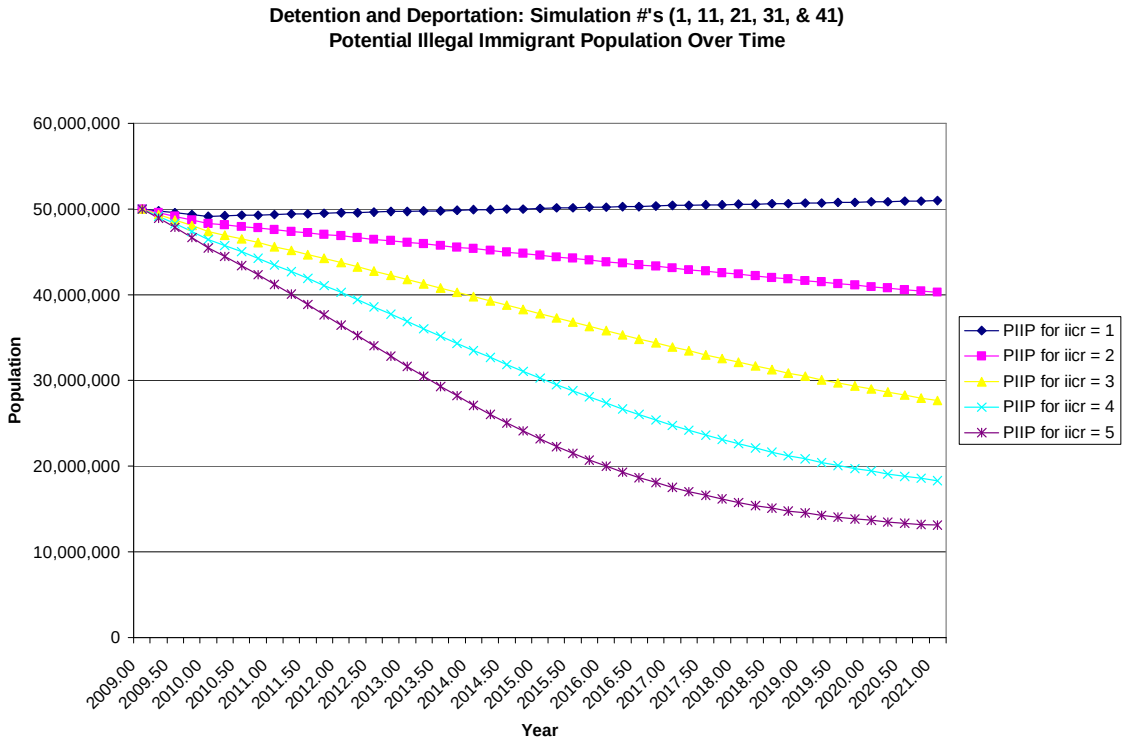


Chart 2

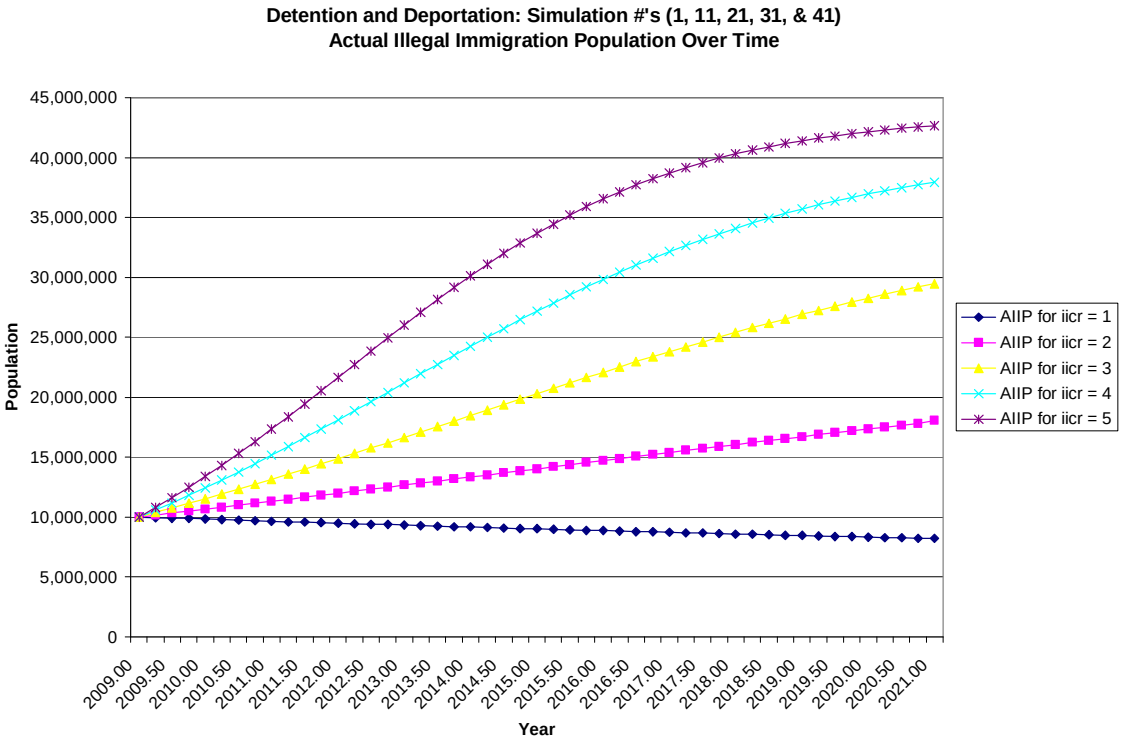


Chart 3

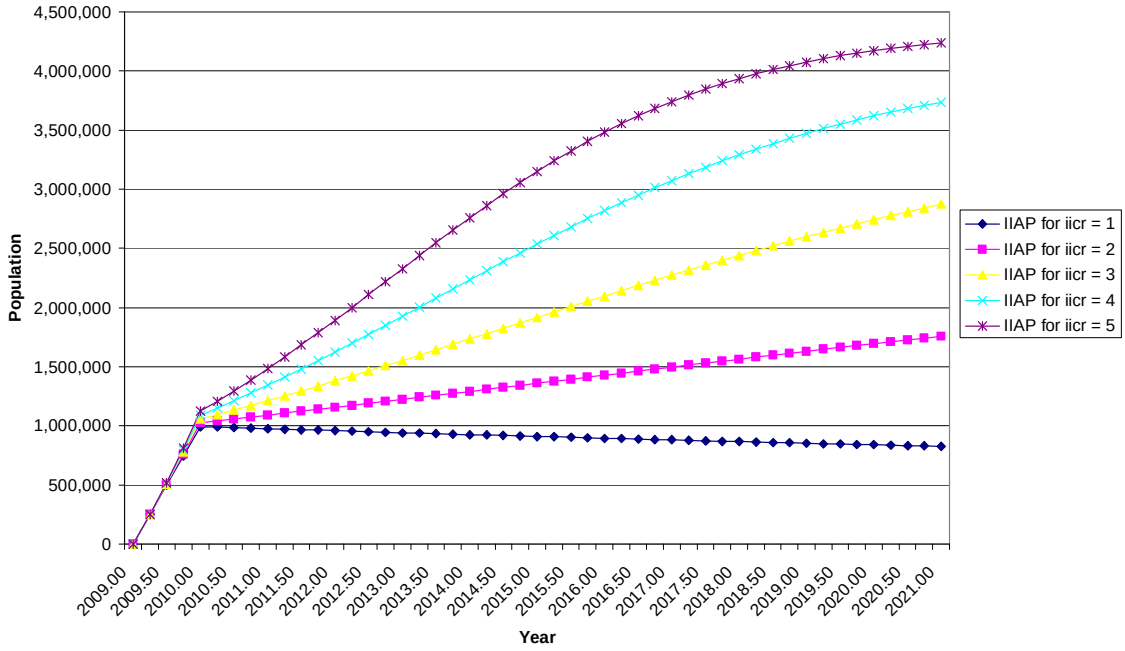


Chart 4

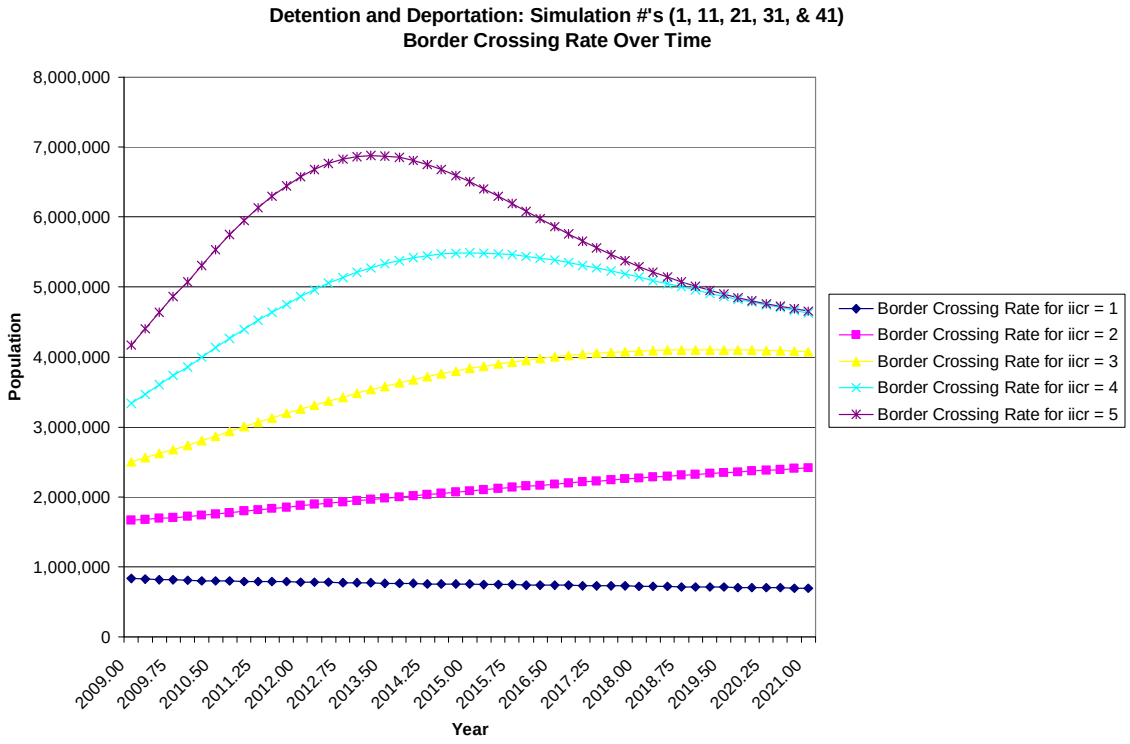


Chart 5

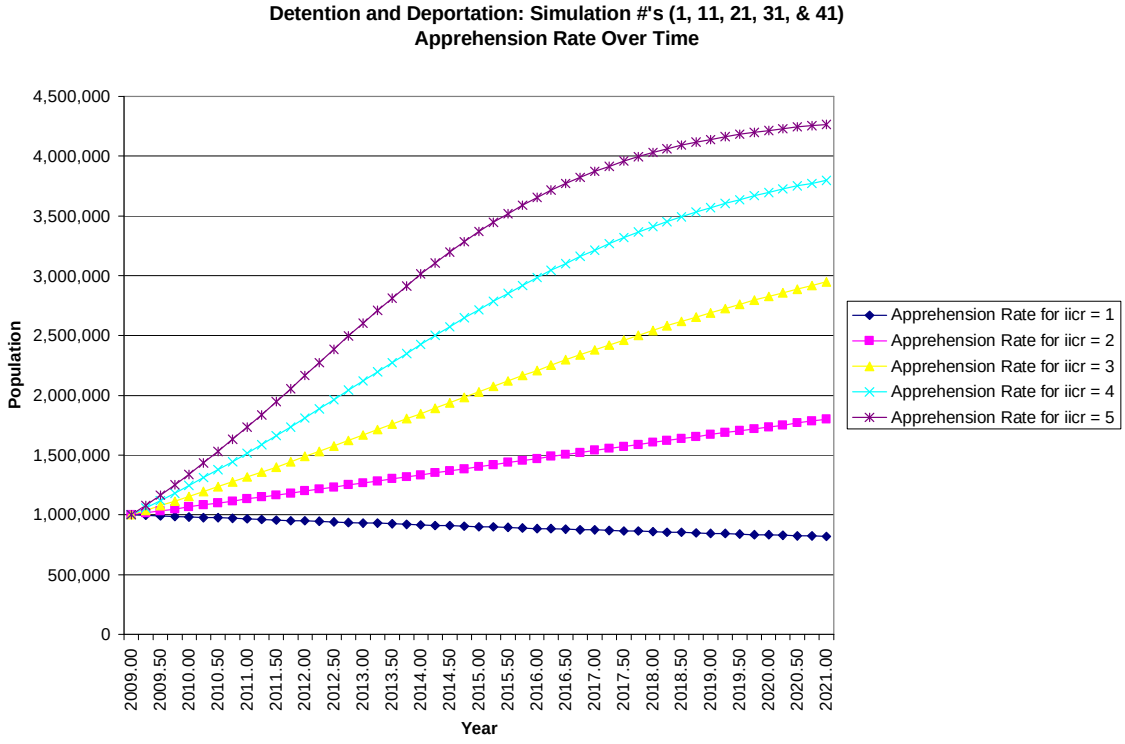


Chart 6

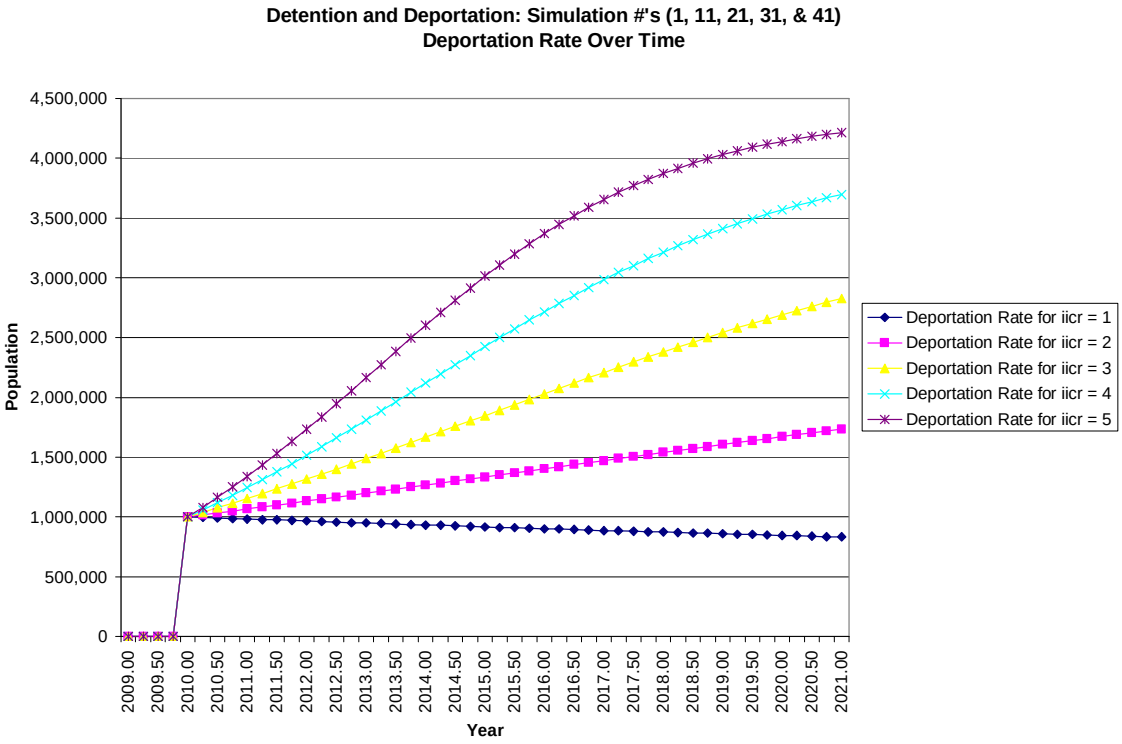


Chart 7

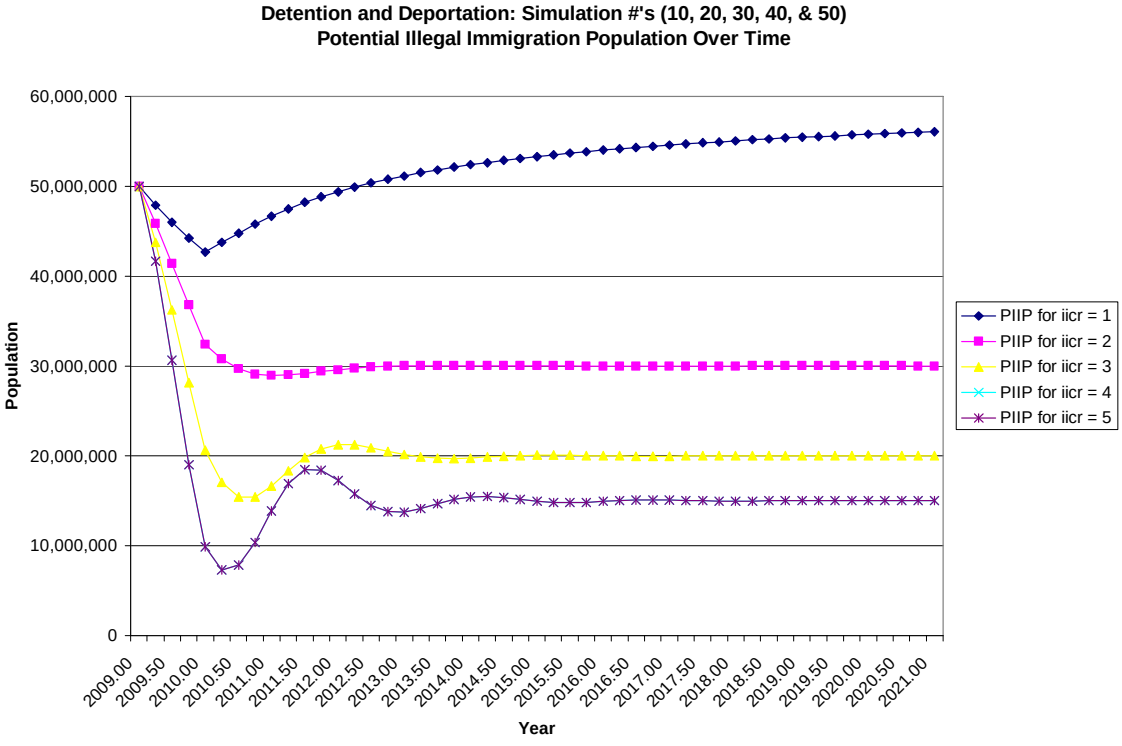


Chart 8

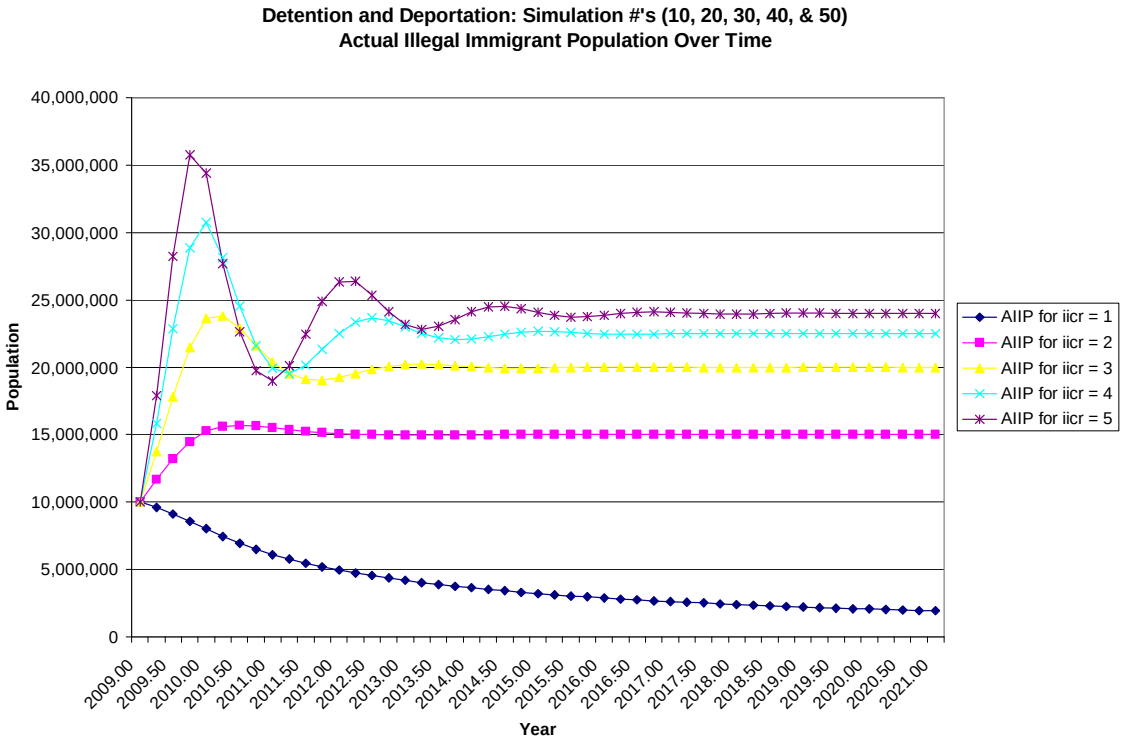


Chart 9

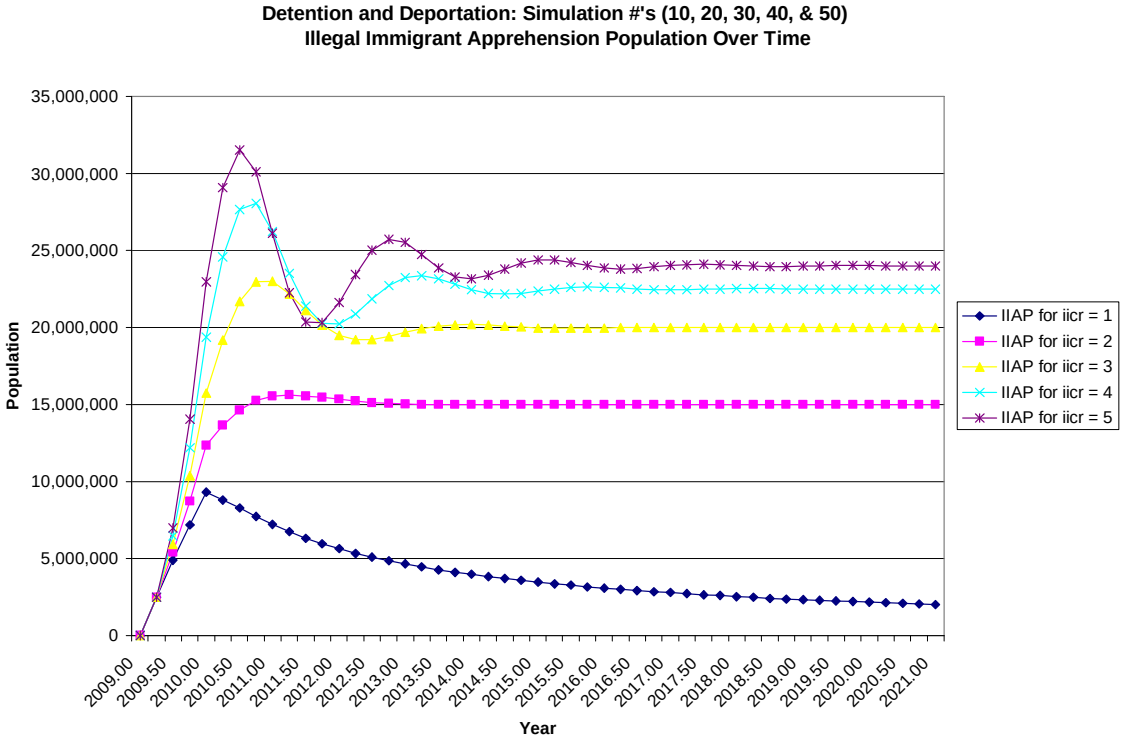


Chart 10

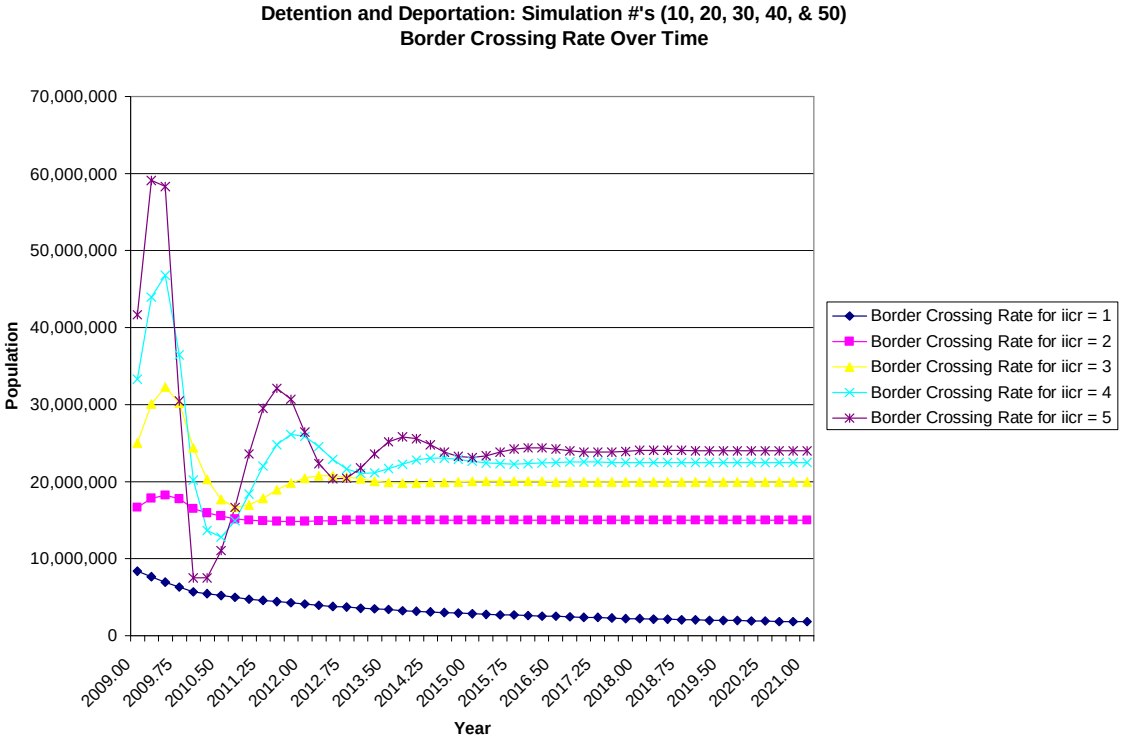


Chart 11

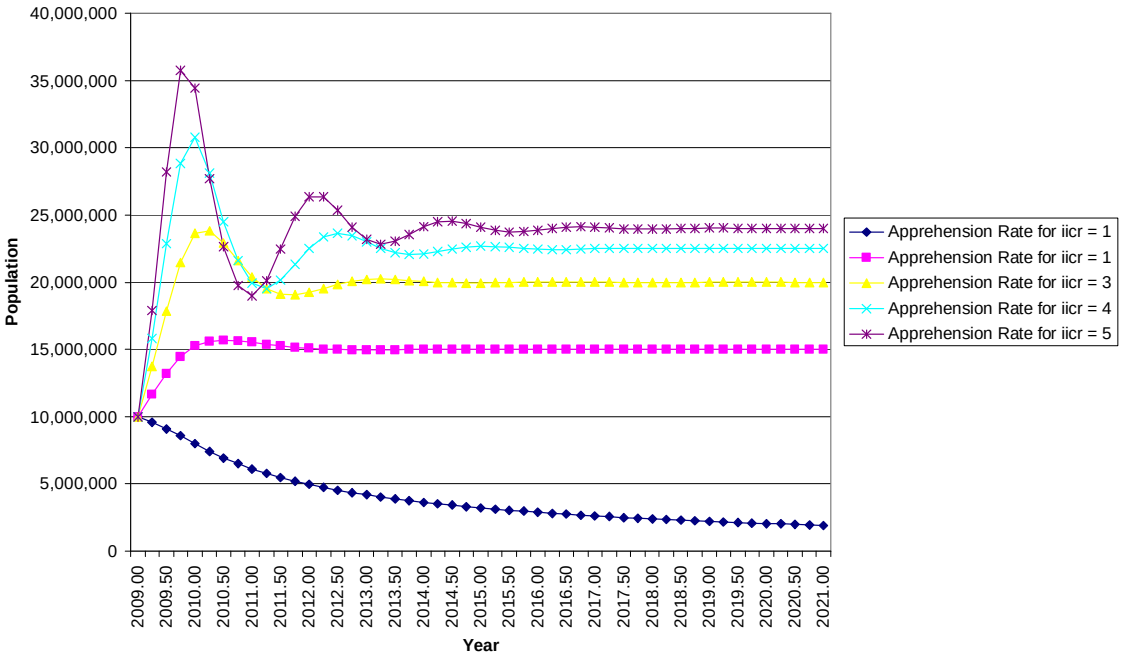
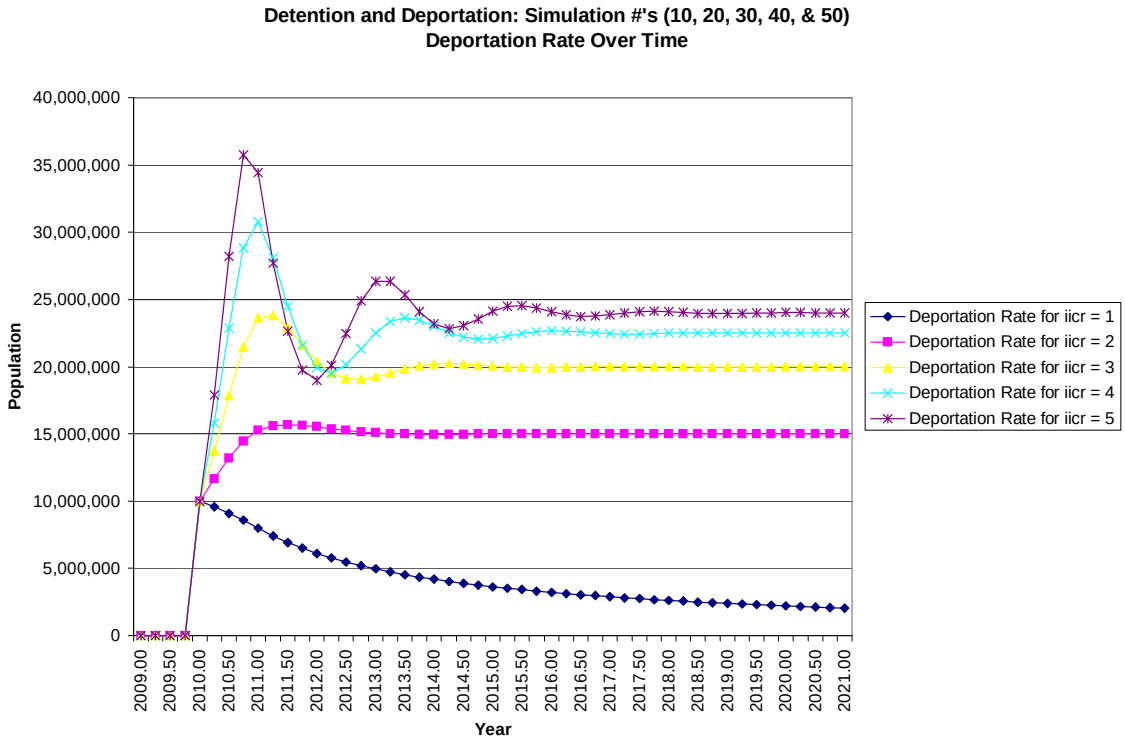


Chart 12



VI.1.2 Detention and Deportation with Amnesty

Fifty simulations were also run for the Detention and Deportation with Amnesty case in this section. For each respective illegal immigration contact rate (1-5), the border crossivity, amnesty, and apprehension percentage were incrementally increased by 10%, while the deportation delay was kept constant at 1 year. Hence, more theoretical data was inputted to examine and discuss the impact of amnesty and detention and deportation on a total population of 60 million potential and actual illegal immigrants communicating with each other.

The charts in this section display the results for each variable in this case when the border crossivity variable was set to 10% and 100% respectively. Charts (13 – 20) provide the results on communication between potential and actual illegal immigrants

when the border crossivity is 10%. Charts (21-28) display the results when the border crossivity is 100%. The remaining charts for the base case are located in Appendix C.

The results of the Detention and Deportation case are very analogous to the Detention and Deportation with Amnesty case. In addition, comparing the behavior of the second case to the base case yielded the same types of trends and results. In short, increasing border crossivity and the iicr resulted in more total illegal crossings and growth in the actual illegal immigrant population, and the increase in the amnesty and apprehension percentages produced increasing or decreasing exponential trends and oscillation.

A key observation in this case is that even with a policy of deportation the PIIP still exponentially decreases. The PIIP decreases because the AIIP is drained by the amnesty, apprehension, and deportation rates. Since the PAIIP model is based on feedback, anytime the AIIP begins to exponentially decrease, the ability for communication between actual and potential illegal immigrants decreases.

The overall increase in the border crossing rate for Case #2 is attributed to the assumption behind its design, specifically the border crossivity due to AP parameter. The border crossivity due to AP parameter increases the border crossivity variable and produces more illegal border crossings. Therefore, the PAIIP model can not be used to make the argument that a policy of amnesty increases illegal border crossings. However, the PAIIP model does show that granting amnesty theoretically causes an exponential increase in the amnesty population.

One reason that supports the theoretical exponential growth of the amnesty population is that legalization enables immigrants to sponsor their family members

(Rytina, 2002, p. 5). In short, if an immigrant becomes legal through amnesty, they are entitled to bring over a loved one because it is the law. Furthermore, the trends from the total amnesty rate and total amnesty population support the argument that there are indirect effects of legalization programs, specifically amnestied immigrants utilizing chain migration to either legally or illegally bring over their family members and loved ones into the United States (Rytina, 2002).

The following tables provide the theoretical data that was calculated and inputted into the PAIIP model's Detention and Deportation with Amnesty case simulations:

Parameters (Theoretical) Inputted for (All) Simulations

PIIP	**AIIP**	**IIAP**
50 million	10 million	Calculated by PAIIP Model

Parameters (Theoretical) Inputted for (All) Simulations

AP	**N**	**Deportation Delay**
0	60 million	1 year

Parameters (Theoretical) Inputted for (All) Simulations

Border Crossing Rate	**Apprehension Rate**
Calculated by PAIIP Model	Calculated by PAIIP Model

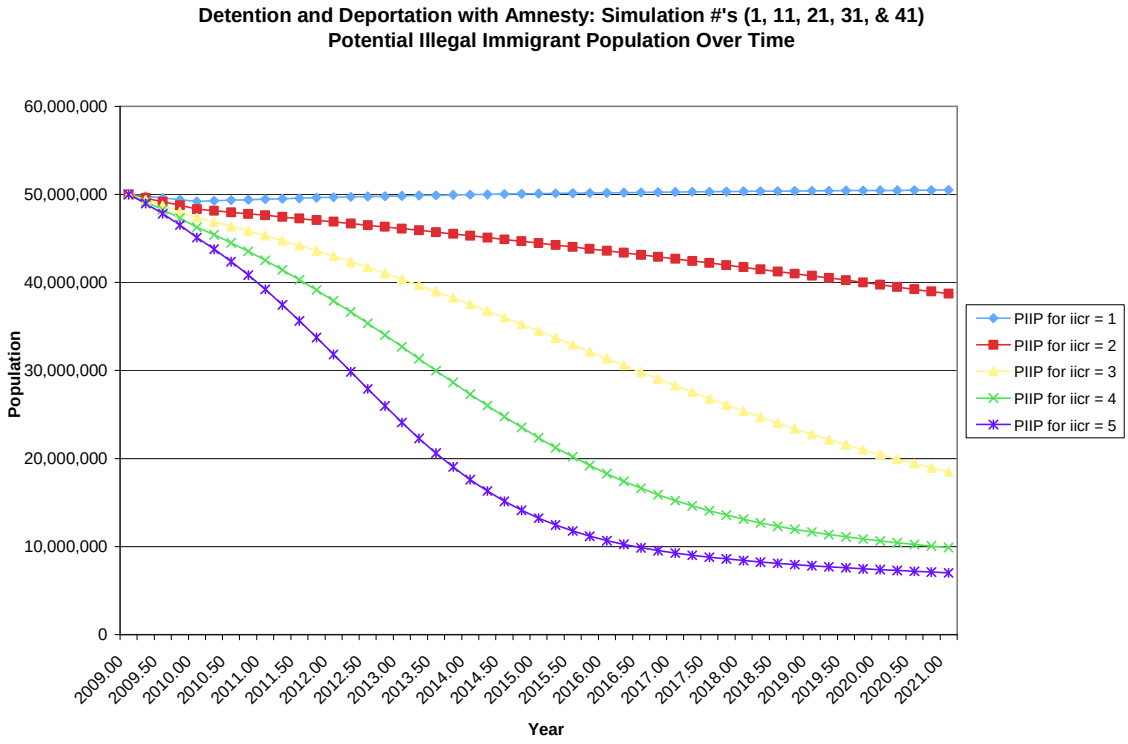
Parameters (Theoretical) Inputted for (All) Simulations

Amnesty Rate	**Deportation Rate**
Calculated by PAIIP Model	Calculated by PAIIP Model

Simulation #	**IICR**	**Border Crossivity**	**Apprehension %**	**Amnesty Percentage**
1	1	10%	10%	10%
2	1	20%	20%	20%
3	1	30%	30%	40%
4	1	40%	40%	40%
5	1	50%	50%	50%
6	1	60%	60%	60%
7	1	70%	70%	70%
8	1	80%	80%	80%
9	1	90%	90%	90%
10	1	100%	100%	100%

Simulation #	IICR	Border Crossivity	Apprehension %	Amnesty Percentage
11	2	10%	10%	10%
12	2	20%	20%	20%
13	2	30%	30%	40%
14	2	40%	40%	40%
15	2	50%	50%	50%
16	2	60%	60%	60%
17	2	70%	70%	70%
18	2	80%	80%	80%
19	2	90%	90%	90%
20	2	100%	100%	100%
Simulation #	**IICR**	**Border Crossivity**	**Apprehension %**	**Amnesty Percentage**
21	3	10%	10%	10%
22	3	20%	20%	20%
23	3	30%	30%	40%
24	3	40%	40%	40%
25	3	50%	50%	50%
26	3	60%	60%	60%
27	3	70%	70%	70%
28	3	80%	80%	80%
29	3	90%	90%	90%
30	3	100%	100%	100%
Simulation #	**IICR**	**Border Crossivity**	**Apprehension %**	**Amnesty Percentage**
31	4	10%	10%	10%
32	4	20%	20%	20%
33	4	30%	30%	40%
34	4	40%	40%	40%
35	4	50%	50%	50%
36	4	60%	60%	60%
37	4	70%	70%	70%
38	4	80%	80%	80%
39	4	90%	90%	90%
40	4	100%	100%	100%
Simulation #	**IICR**	**Border Crossivity**	**Apprehension %**	**Amnesty Percentage**
41	5	10%	10%	10%
42	5	20%	20%	20%
43	5	30%	30%	40%
44	5	40%	40%	40%
45	5	50%	50%	50%
46	5	60%	60%	60%
47	5	70%	70%	70%
48	5	80%	80%	80%
49	5	90%	90%	90%
50	5	100%	100%	100%

Chart 13



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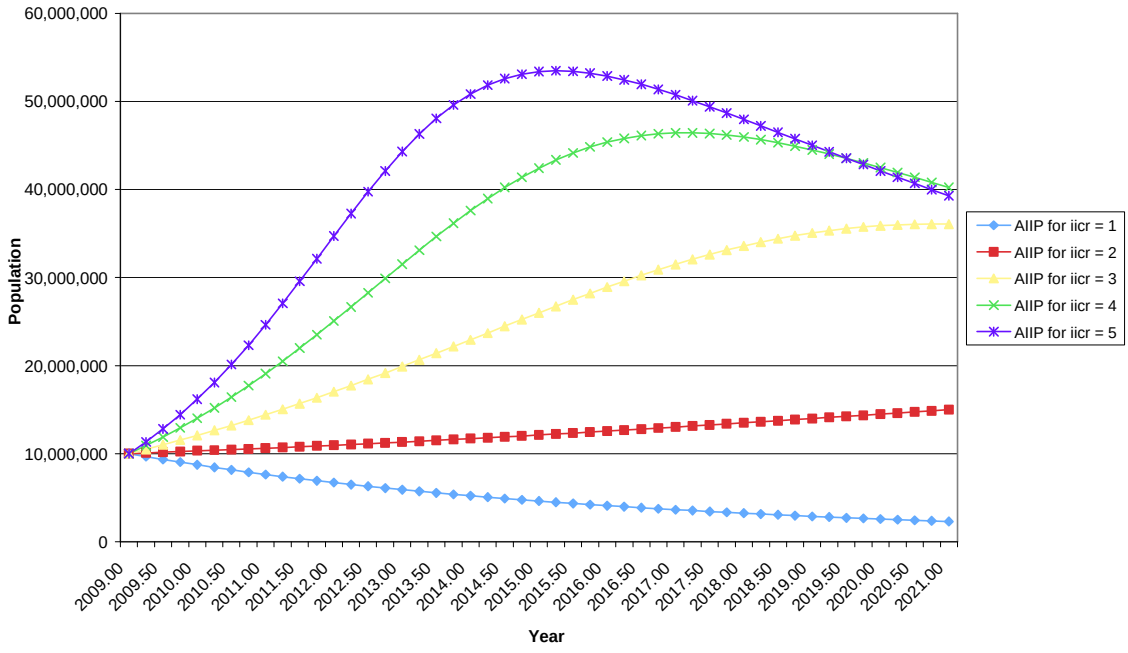

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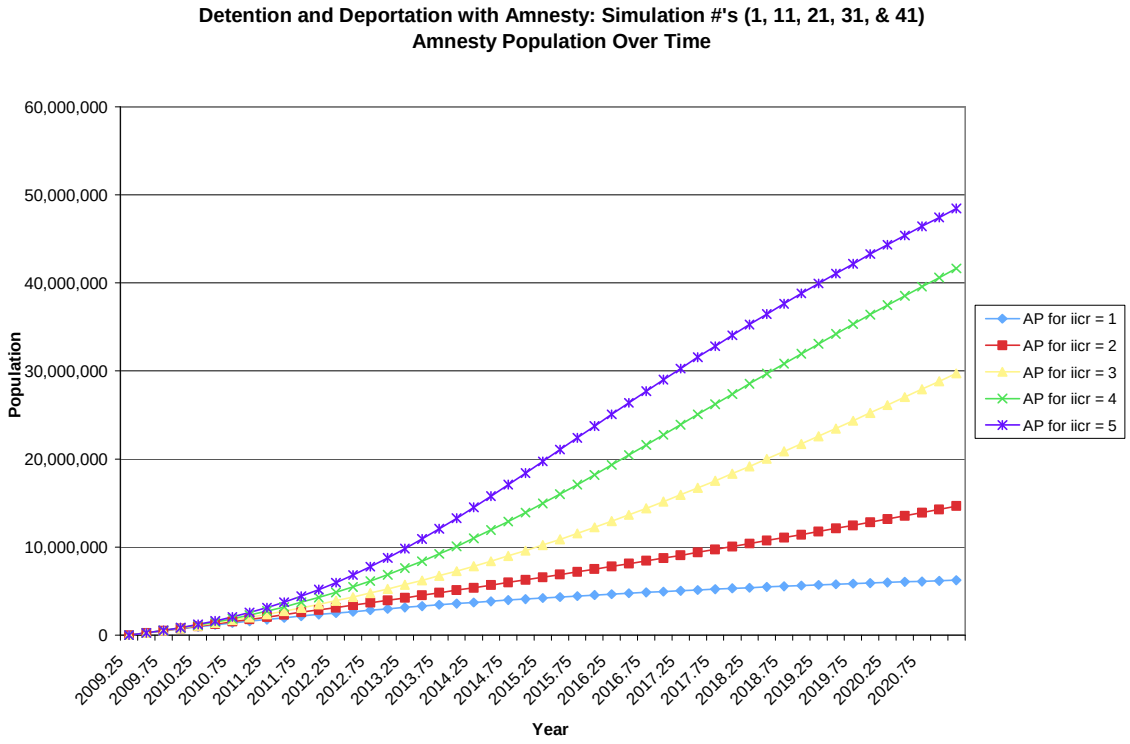

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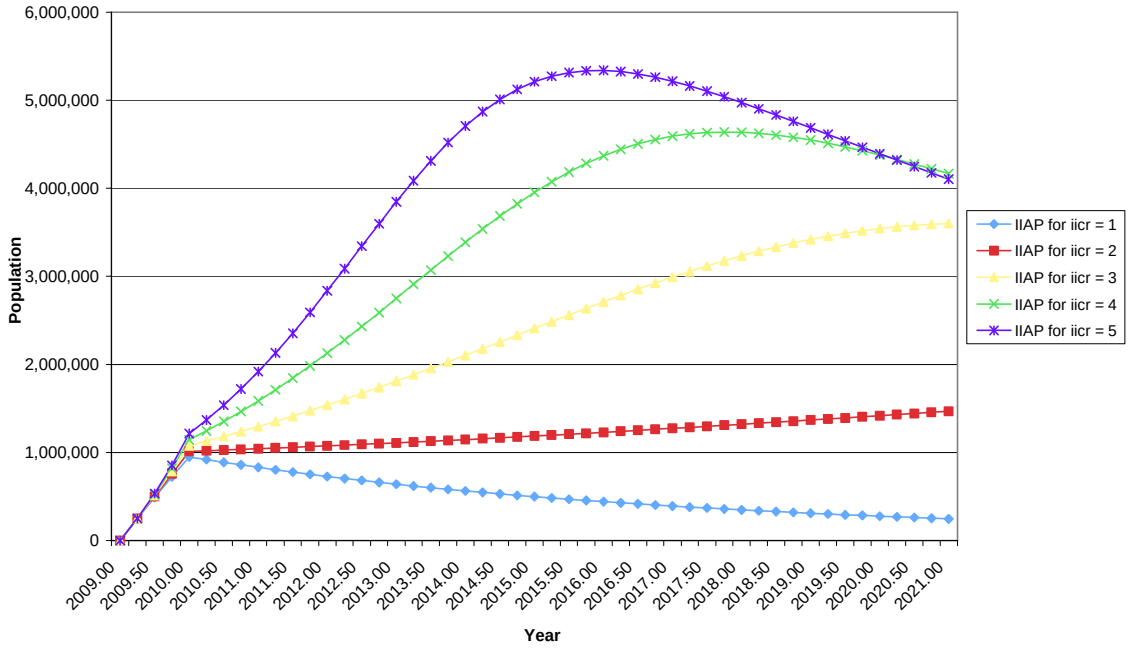

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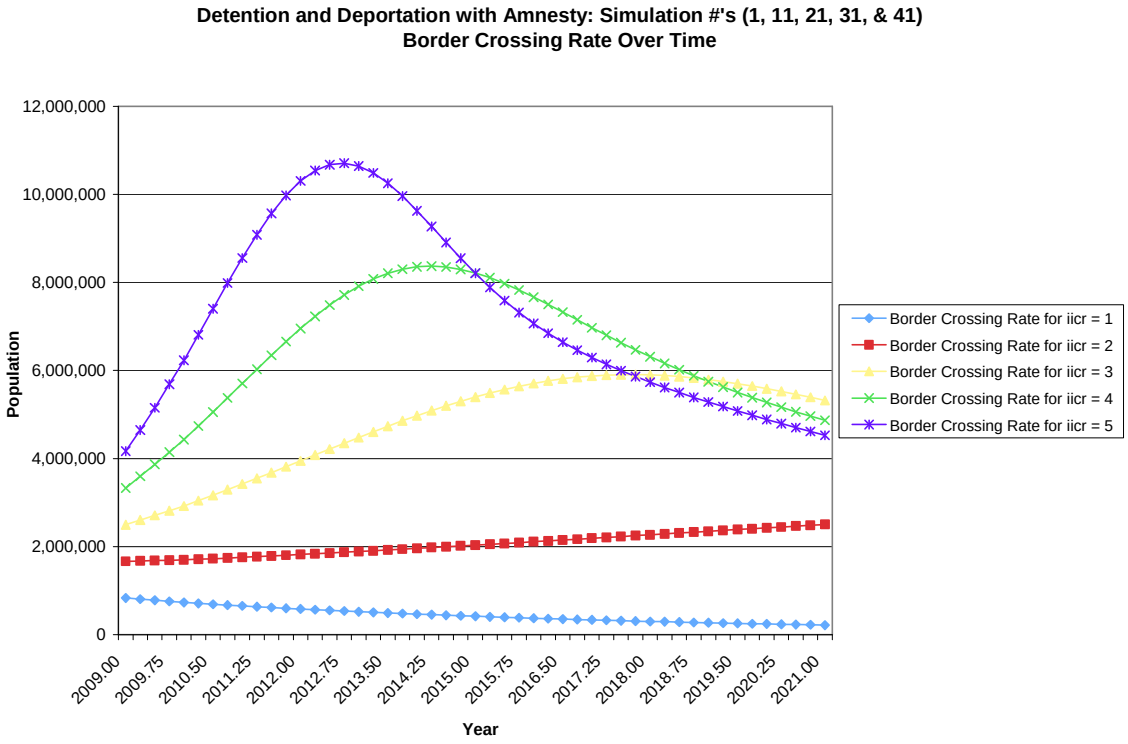

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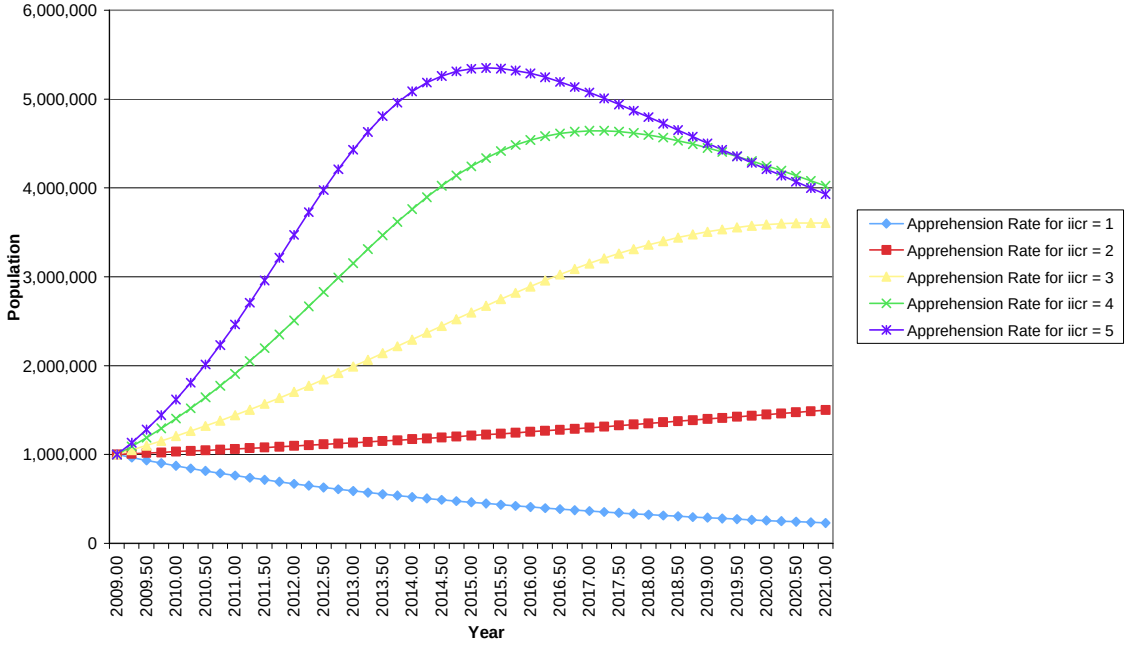

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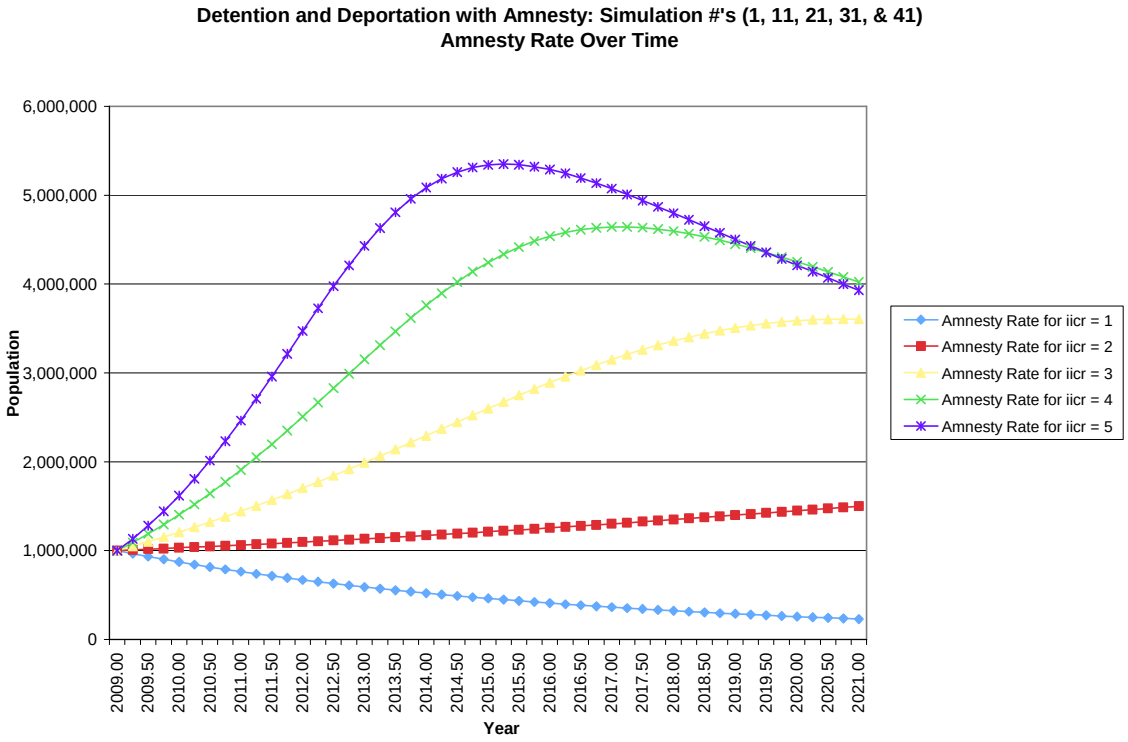

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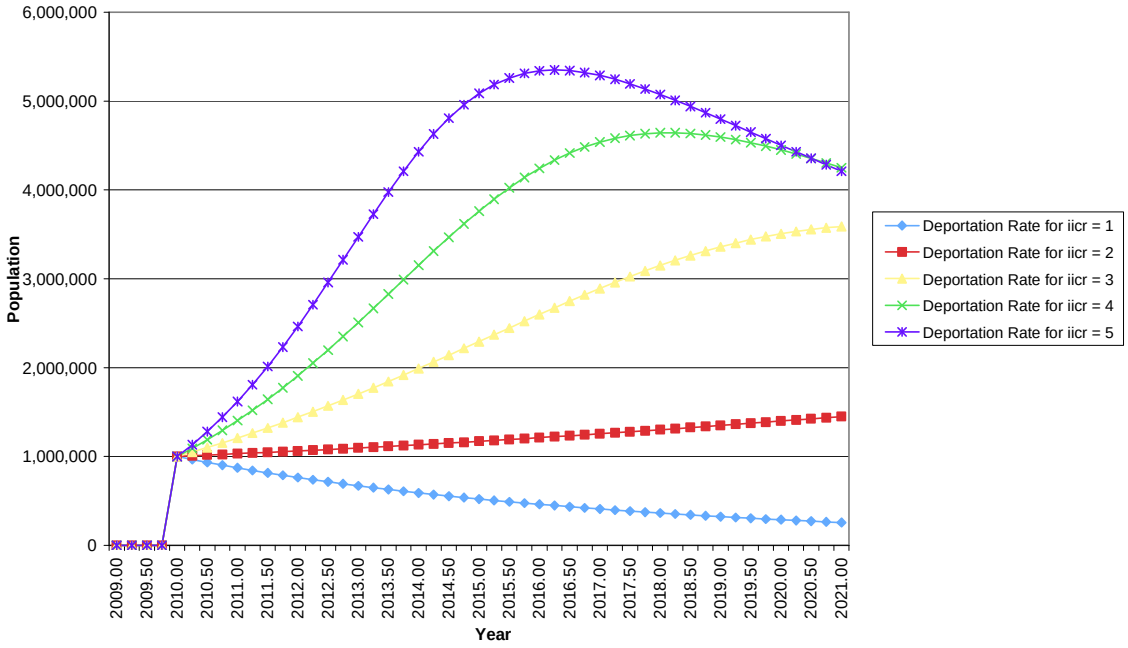

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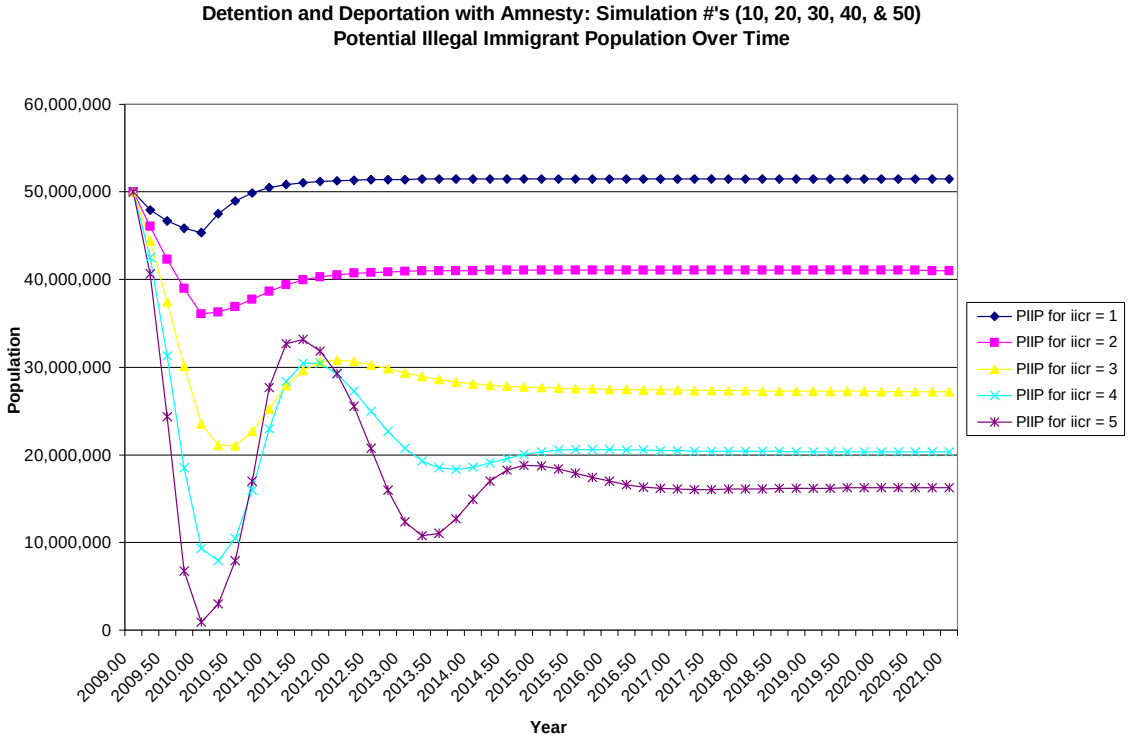

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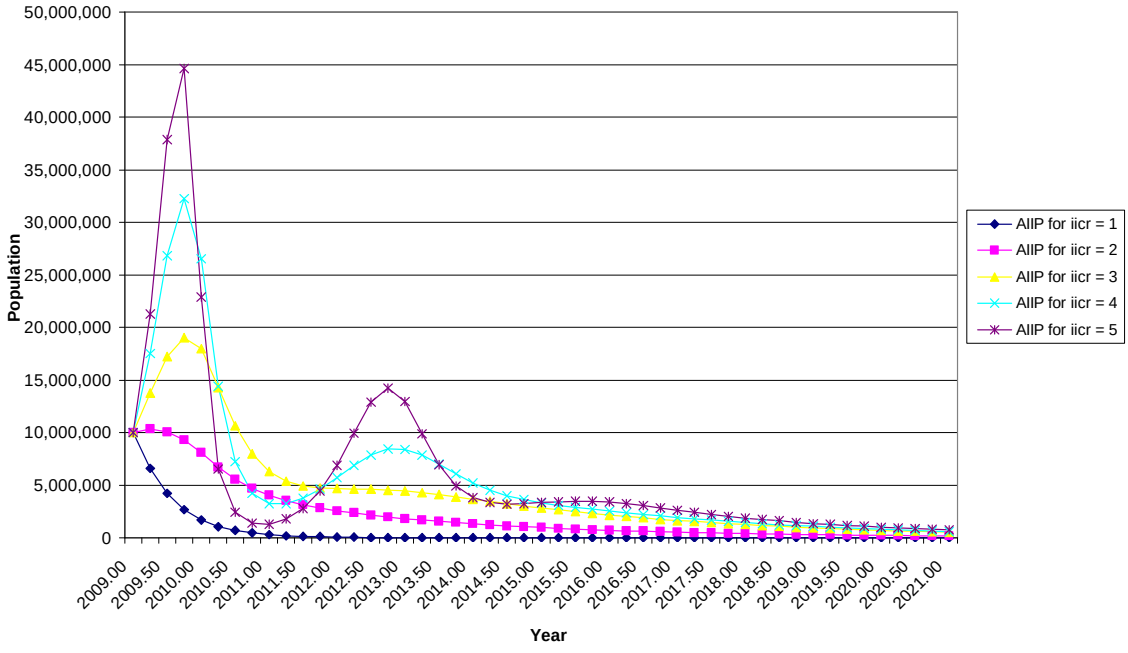

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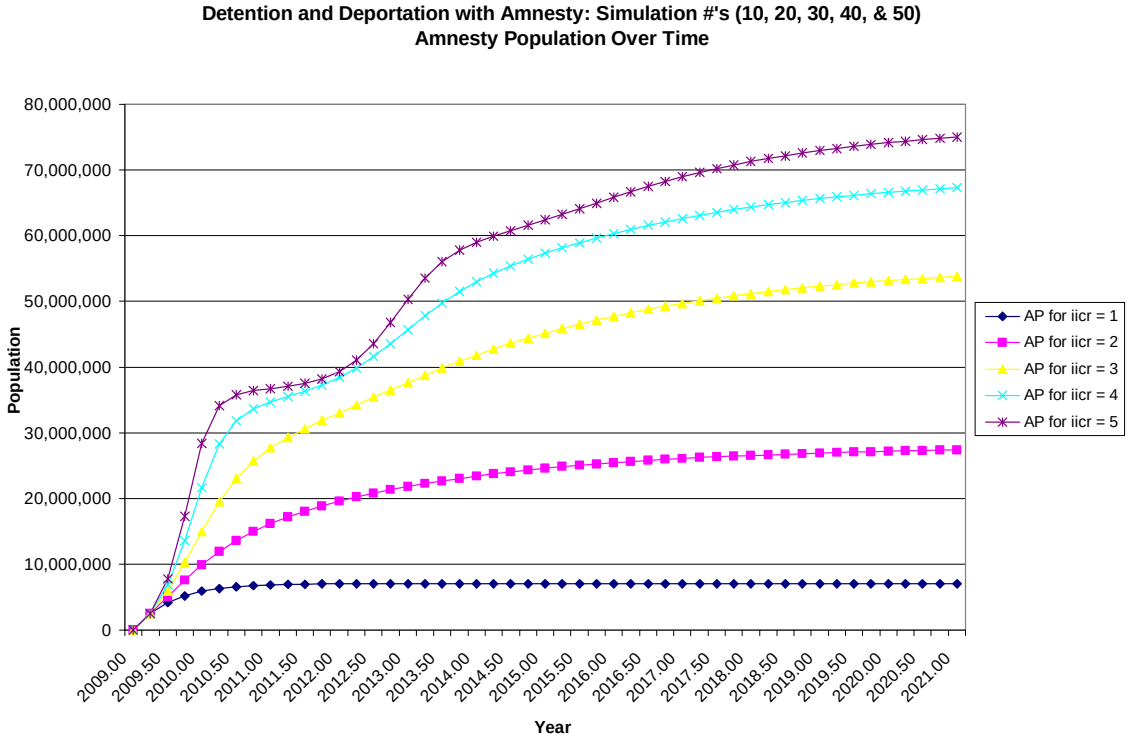

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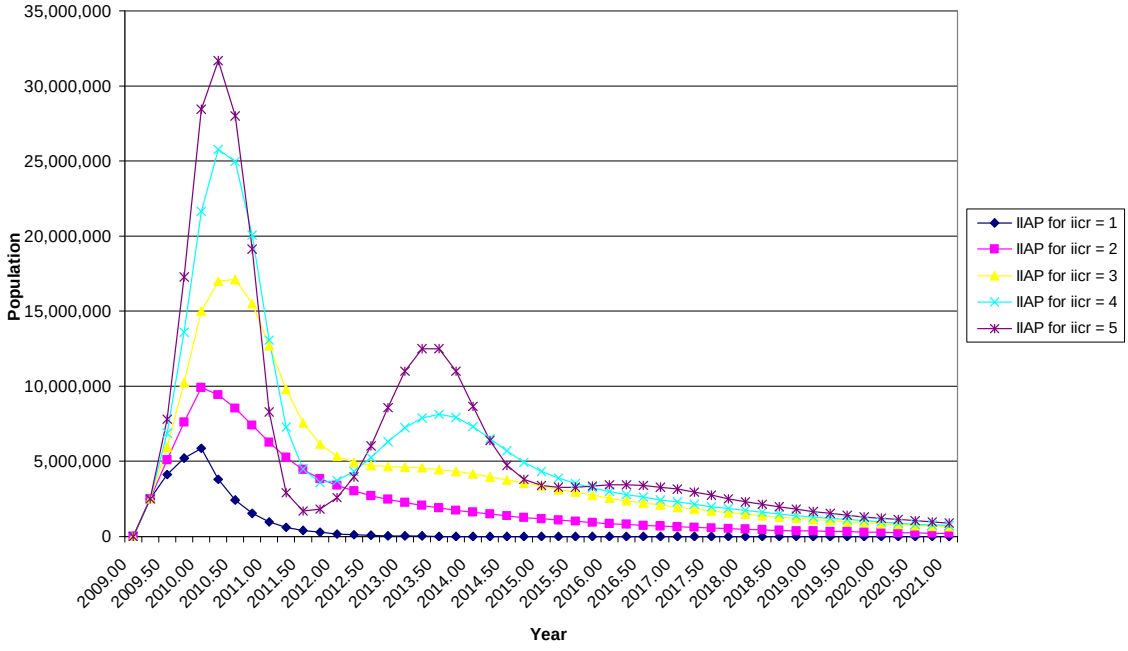

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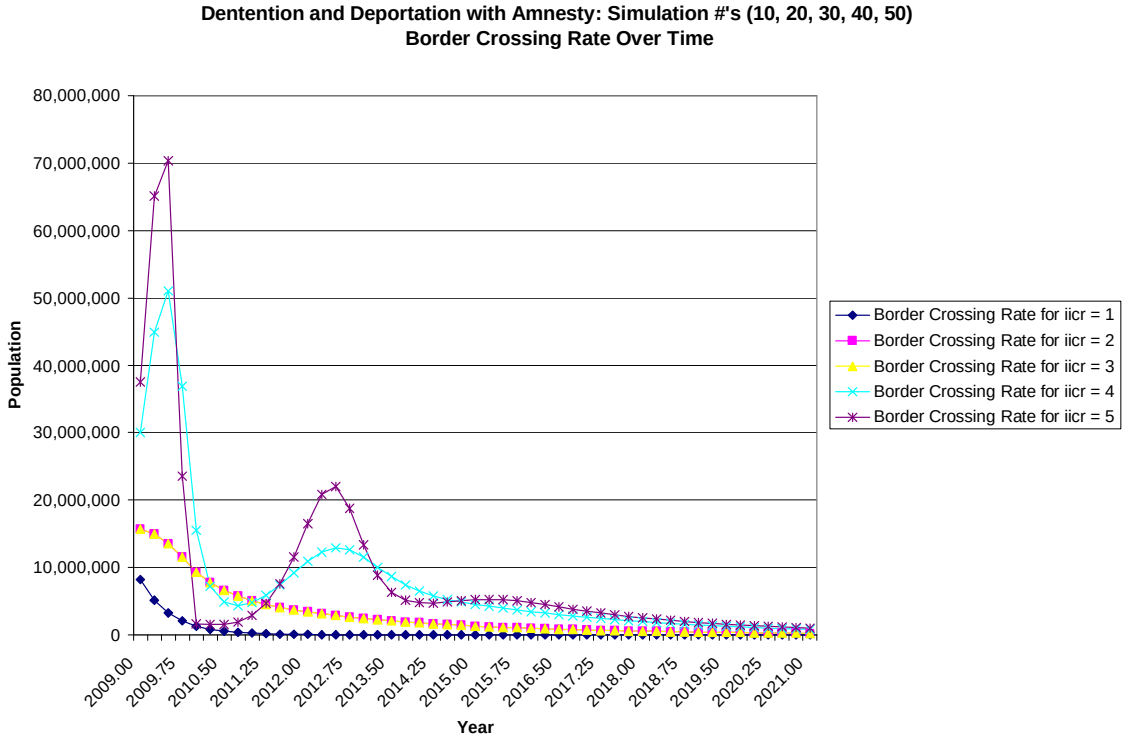

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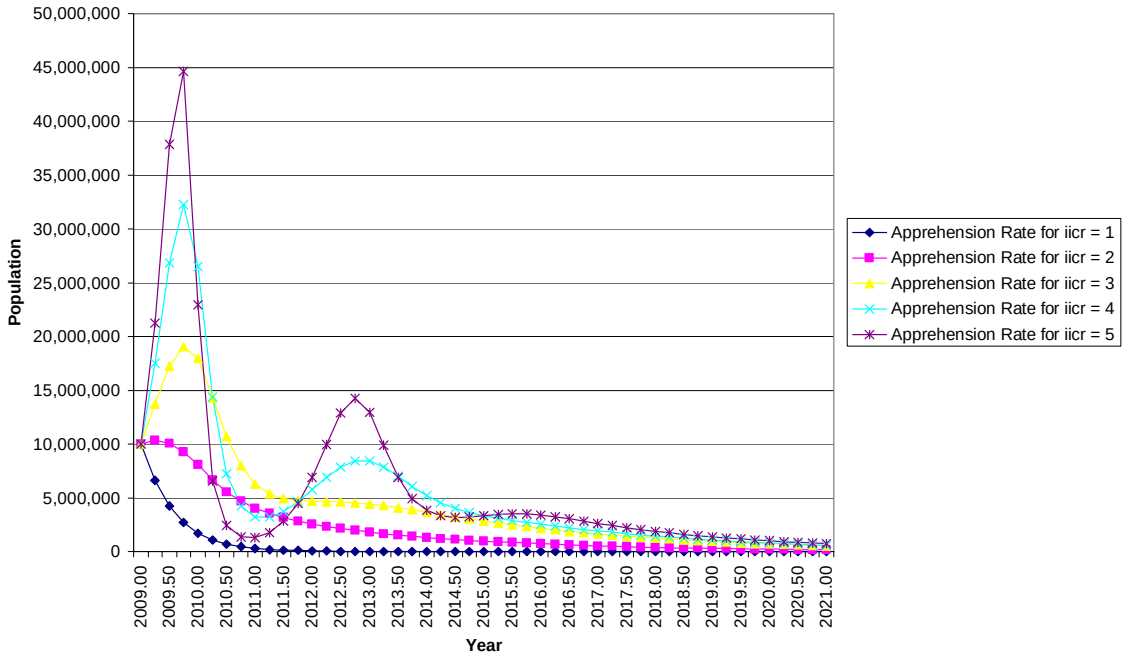

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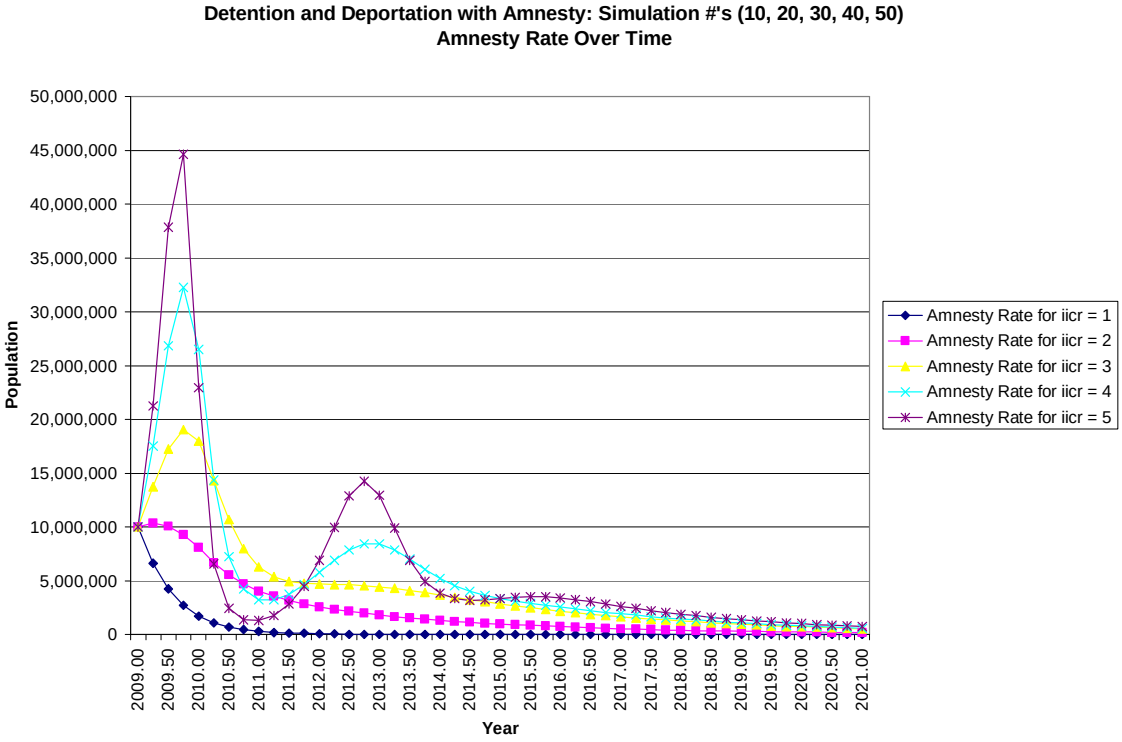

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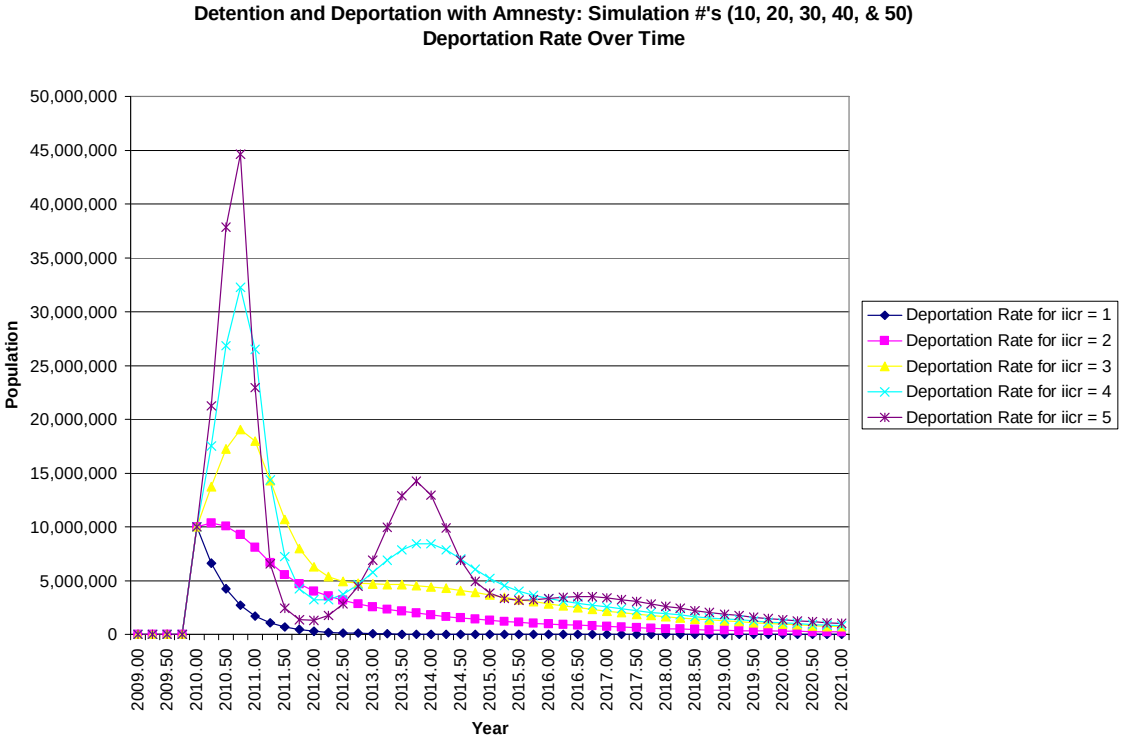


VI.1.3 PAIIP Model Results vs Research Questions

The PAIIP model was developed to test the ability of deportation, amnesty, and detention to decrease illegal immigration, and the results from the PAIIP model are comparable to the research questions of this study.

The first research question was:

1. **Which policy or combination of policies has the best chance of limiting illegal migration?**

The PAIIP model's design and results are based on the theory of communication between actual and potential illegal immigrants. With over 100 simulation results, both cases for the PAIIP model reveal that an increase in the content of information (border crossvity) and the ability for an actual illegal immigrant to communicate reliable information to as many as five immigrants (iicr) who reside outside of the United States may be countered by improving border security measures (apprehension percentage). Improving the capacity to locate and apprehend illegal immigrants ultimately decreases growth in the actual illegal immigrant population. Although apprehension and detention and deportation in both cases reduce the population of illegal immigrants in the United States, and the policy of amnesty helps bring actual illegal immigrants out of hiding, the ability to totally eradicate communication between people on any scale through public policy is very arduous and practically unfeasible.

The literature review does provide some insight towards supporting the argument of the inability to implement polices that are able to effectively combat communication between potential and actual illegal immigrants. For instance, every year at least one million deportable aliens are located by the border patrol. Each night at least 27,500

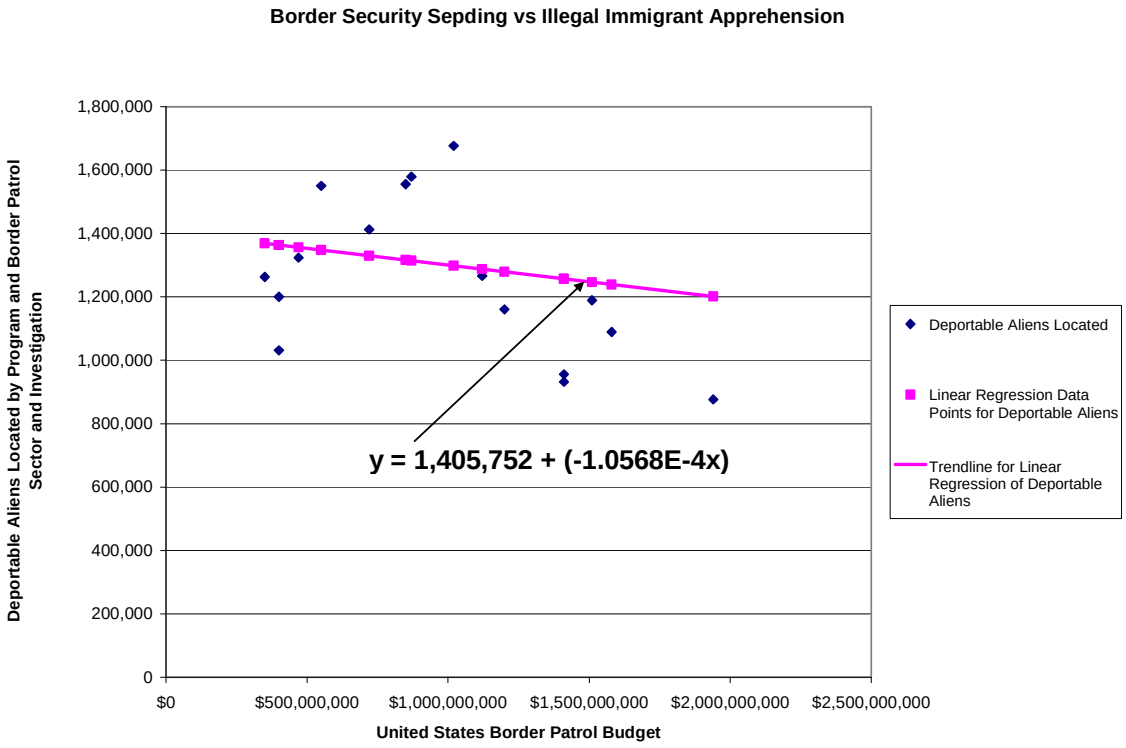
illegal immigrants are held in detention. However, there still exist political, economic, and social factors that motivate illegal border crossings of which chain migration is a result. For example, Abraham et al. (2006), argue that many illegal migrants seek jobs with pay that would otherwise be unattainable in their native countries. In addition, as articulated by Wegge (1998) and Edwards (2006), chain migration increases the ability for Mexicans and people other than Mexicans (OTMs) to enter the United States because their networks of knowledge and communication between potential and actual migrants, and human smugglers assist towards illegal immigration. Therefore, the various motivations of potential immigrants, chain migration, and population growth help explain why the policies of detention and deportation and amnesty do not completely eradicate border crossings.

2. What does Border Security need to be successful at executing their agenda and goals?

In reference to the PAIIP model's results, as illegal immigrants are apprehended, detained, and deported, they are returned back into the potential illegal immigrant population. When an illegal immigrant is deported back home, he or she may communicate with a friend or relative and share his or her new knowledge and experiences about the United States; this has the strong probability of stimulating the desire for an illegal border cross. However, the fact that the immigrant, who may be a friend or relative of the person they are sharing this information with, was forcibly apprehended and deported, should raise a sense of risk and weaken the willingness of both parties to attempt illegal entry into the United States.

Since the policy of deportation puts immigrants back into the potential illegal immigrant pool, the biometric technologies such as fingerprint, facial, and iris technology are essential for border security (Kingsbury, 2003, p. 4). These procedures are already being implemented into the United States Citizenship and Immigration Services (USCIS) activities. In addition, the consideration of Congress to fund UAVs and RPVs, as technological tools to assist border patrols is also a legitimate investment decision (Blazakis, 2004, p. 3).

Chart 1



The exponential increase in government spending on the border patrol makes sense because an increase in border patrol funding, coupled with the latest technological innovations should help towards reducing illegal border crossings and deterring illegal immigrants who attempt to re-enter the United States once they have been deported.

Therefore, ensuring that illegal immigrants who desire to enter the country are stopped requires a strong and organized ICE, CBP, and National Border Patrol Strategy.

VII. Policy Recommendations

Border security and illegal immigration are important public policy issues that require careful decision making by political actors. Assuming the validity of the chain migration theory and other assumptions incorporated into the PAIIP model, we find that no single or combination of policies will solve this problem. The policy recommendations outlined below focus on the economic and national security aspects of border security and illegal immigration. Overall, the PAIIP model was better at examining the deterrence of illegal immigration than dealing with the national security piece or, more specifically, preventing terrorism. .

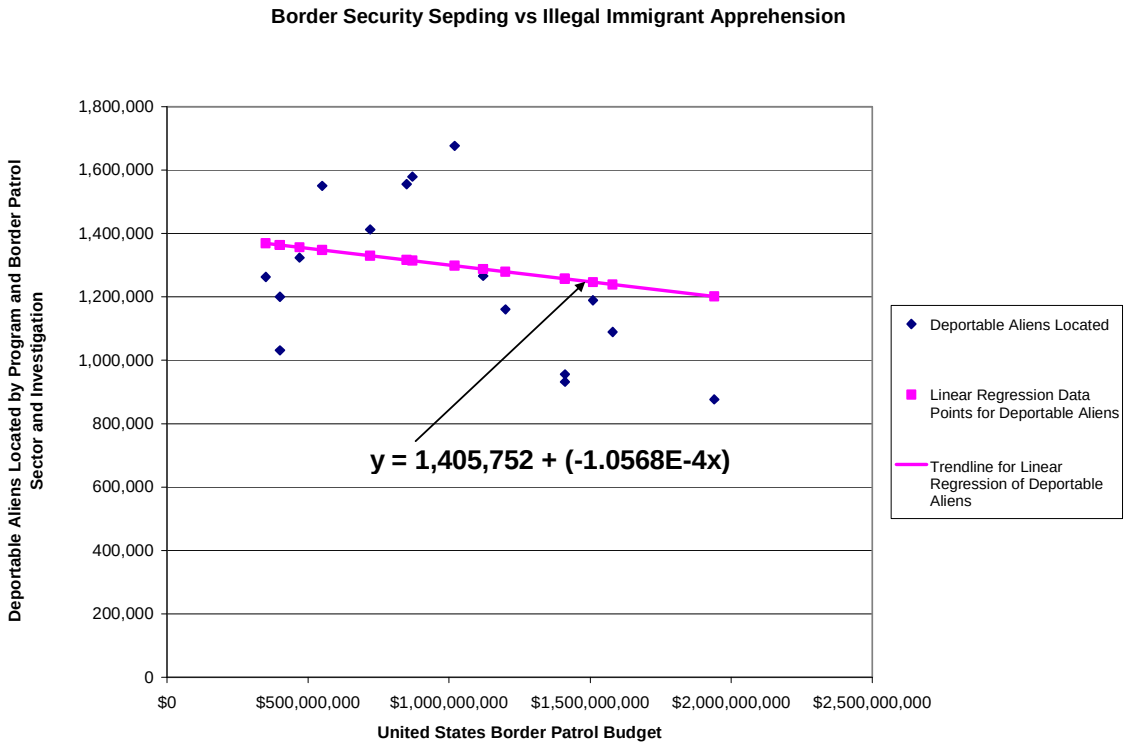
VII.1. The United States government should expand its temporary work card program instead of granting amnesty.

One policy remedy that may curtail illegal border crossings and border security spending is the expansion of the temporary work card program, specifically increasing the number of temporary work cards. The hypothesis in this research study focuses on the argument of communication between potential and actual illegal immigrants. Therefore, this research study acknowledges how a policy to allow more immigrants to enter legally and become temporarily employed automatically provides them with the opportunity to share their experiences and knowledge.

The most recent census data reports that one out of every ten people born in Mexico currently live in the United States. If, for instance, more Mexicans were given

temporary work cards, there would be no real legitimate restriction on their ability to communicate with family and friends across the border. If OTMs are given more temporary work cards, they could communicate across the globe as well. Thus, this research study also recognizes that granting more temporary work cards runs counter to its hypothesis, because it would potentially increase border crossivity and stimulate more illegal crossings. However, there are strengths and benefits of a larger temporary work program combined with solid oversight and enforcement.

Chart 1



The increase in temporary work cards may help towards reducing some of the costs incurred from border security spending. For instance, Massey (2005) reports that it costs the Border Patrol approximately $1,700 to apprehend an illegal immigrant. Kolodner (2006) reports that it costs $95 a night to detain an illegal immigrant. Simcox

(1997) reported that ten years after the implementation of the IRCA of 1986, an estimated $102.1 billion was spent. Furthermore, the amount of money spent on Border Patrol continues to exponentially increase despite the fact that nearly 500,000 illegal immigrants a year are able to penetrate the borders of the United States and become part of the millions of illegal immigrants that already reside in America today.

Presently, the United States annually allocates only 5,000 employment-based green cards for workers in less-skilled jobs and 66,000 temporary work cards a year in less-skilled jobs besides agriculture. In reference to worker movement, the social networks between Mexicans residing in Mexico and the United States, coupled with the integration of economic growth in various sectors, has made the process of sealing the border very arduous and a failed policy initiative (Massey, 2005, p. 5). For a small application fee, which many migrant workers would be willing to pay, Massey (2005) recommends that the United States should expand the temporary worker program that enables the applicant to enter, live, and work for two years without constraints. Despite the fact that workers with temporary work cards will not have the opportunity for naturalization or the ability to legally bring over their relatives or friends, at least they have a medium for employment and the opportunity to earn a legal income. Therefore, the federal government should increase the amount of temporary work cards granted to Mexicans and OTMS.

Finally, in reference to the PAIIP model's cases, not only do their results reflect some of the challenges in trying to find a solution to border security and illegal immigration, but also the notion that the responsibility of the United States government is to ensure that their decisions on this public policy issue do not conflict with one another.

Moreover, the literature review and PAIIP model results indicate that future public policies should enable agencies such as ICE and CBP to effectively perform their jobs and achieve their respective goals. Therefore, the ability for border security to thoroughly execute their objectives is based on immigration policies and solutions that incorporate the cooperation of the government at the local, state, and national level.

VIII. Conclusion

The challenge of providing border security and deterring illegal immigration requires sound and prudent public policy. Thus, the PAIIP model was developed with the recognition that an illegal border crossing by immigrants into the United States is a serious public policy problem. The research in this study was primarily done by using secondary data analysis and incorporated systems modeling. In addition, since the PAIIP model is a deductive systems model based on theory, only hypothetical data was entered into the model to produce its results. Therefore, this study has limitations.

For example, neither real potential nor actual illegal immigrants were interviewed by the researcher for data collection and analysis because there was not enough time, capital, or resources to execute such a feat. Moreover, income, wages, and the overall economy of the United States were not programmed into the design of the PAIIP model. Therefore, the impact of economic issues on the attempt or desire for one to illegally enter the United States was not measured or analyzed in this study. If these various types of information were included in this research, it would have provided more depth to the study.

Like the overall methodology in this research, the PAIIP model's design also has weaknesses and is not perfect. For example, the PAIIP model's cases do not take into account the dynamics of population growth and death. While the PIIP stock has no growth rate, the amnesty population stock does not have a death rate. Since the amnesty population stock has no death rate, the PAIIP model produces rapid exponential growth for this population.

No model is perfect, but it is possible that some of the flaws in the PAIIP model may be fixed to improve its analytic and illustrative capabilities. For example, the PAIIP model may be modified by incorporating the factors of population growth and economic indicators in its PIIP stock and a death rate for the amnesty population stock. Another alternative to the problem with the amnesty population stock would be to eradicate it completely from the entire model but still keep the amnesty rate and amnesty percentage variables. Systems modeling enables population growth analysis. Therefore, the numbers from the amnesty rate(s) may be entered into advanced population growth models to better understand their growth and behavior. The inability to design a better research methodology did not inhibit the capacity of this study to provide insight towards solving the problem of border security and illegal immigration.

That the driving theory behind the design of the PAIIP model is communication between actual illegal immigrants residing in the United States and potential illegal immigrants outside of America, the literature review supports the dynamic hypothesis of the PAIIP model by discussing the impact of chain migration, human smuggling, and the desire of illegal immigrants to find work. Since the PAIIP model tests the policies of detention and deportation and amnesty, the context behind these three strategies and policies was elaborated on, including the enforcement agencies that combat illegal immigration and terrorism such as ICE and CBP, as well as President Obama's immigration reform agenda, which is not firmly fixed at this point.

Also critical to the design and comprehension of the PAIIP model, was the linear regression approach. This technique was used to compare and contrast the exponential increase in border security spending versus the actual amount of deportable aliens located

by the border patrol. The linear regression analysis results revealed that the increase in border patrol spending does not correlate with an increase in illegal immigrants apprehended. Therefore, casual loop diagrams, CLD (1-3), were constructed to map out some of the political, economic, and social factors that stimulate illegal entry and encompass border security issues, specifically the inability of border patrol to apprehend immigrants who are able to successfully to enter the United States illegally.

The literature review was not the only element of support for the theory and design of the PAIIP model. Although the "validation and verification of models is impossible," it does not eradicate the need for proof that a systems model works (Sterman, 2000, p. 846). In order to prove the functionality of the PAIIP model, the same initial values for each stock and rate were inputted into both of its cases[2]. Each case started with a total population of 100 actual and potential illegal immigrants communicating each other (AIIP = 1, PIIP =99). The results from the initial ten simulations revealed that increasing border crossivity and the illegal immigrant contact rate increase illegal crossings and the actual illegal immigrant population. However, the greater the value of the apprehension percentage resulted in an increase in the amount of detentions and deportations; it also decreased the total population of actual illegal immigrants. The amnesty percentage decreased the actual illegal immigrant population as well.

The PAIIP model's results were found to be comparable with the two research questions developed from the literature review of this study. Therefore, the policy recommendation(s) of an expanded temporary work program advocated in this study should be adhered to for several reasons. First, it is estimated that 9 to 10 million

[2] Please refer to the Validation section to see the theoretical data that was inputted into the model.

undocumented immigrants reside in the United States. Second, the yearly cost to detain illegal immigrants is approximately $1 billion. Third, although amnesty is a policy remedy, it has many opponents. For instance, Edwards and Hanson argue that the policy of amnesty through chain migration increases illegal immigration. In addition, the policy of amnesty is irrelevant at preventing terrorism, and the effectiveness of deportation and detention are both useless ploys if a terrorist has already been residing in America. Furthermore, not only do the opponents of amnesty outnumber the supporters, as Rytina warns, but policymakers have to be cognizant of the adverse affects of legalization. Thus, an alternative to amnesty, and potential effective reducer of illegal crossings and cost for border security, is the allocation of more temporary work cards.

The research in this study reveals that there is no one viable solution for border security and illegal immigration. As the PAIIP model evolves in its development and more immigration research is done, the methodology of using systems modeling and applying it to the challenges of border security and illegal immigration will enable public policy officials to create and enforce better immigration policies and regulations. In doing so, policy actors will be able to ensure that there is uniformity and consistency in the policies that tackle border security and illegal immigration and ultimately provide the best national security possible, all the while assuring the continual prosperity of the United States of America.

IX. Appendix

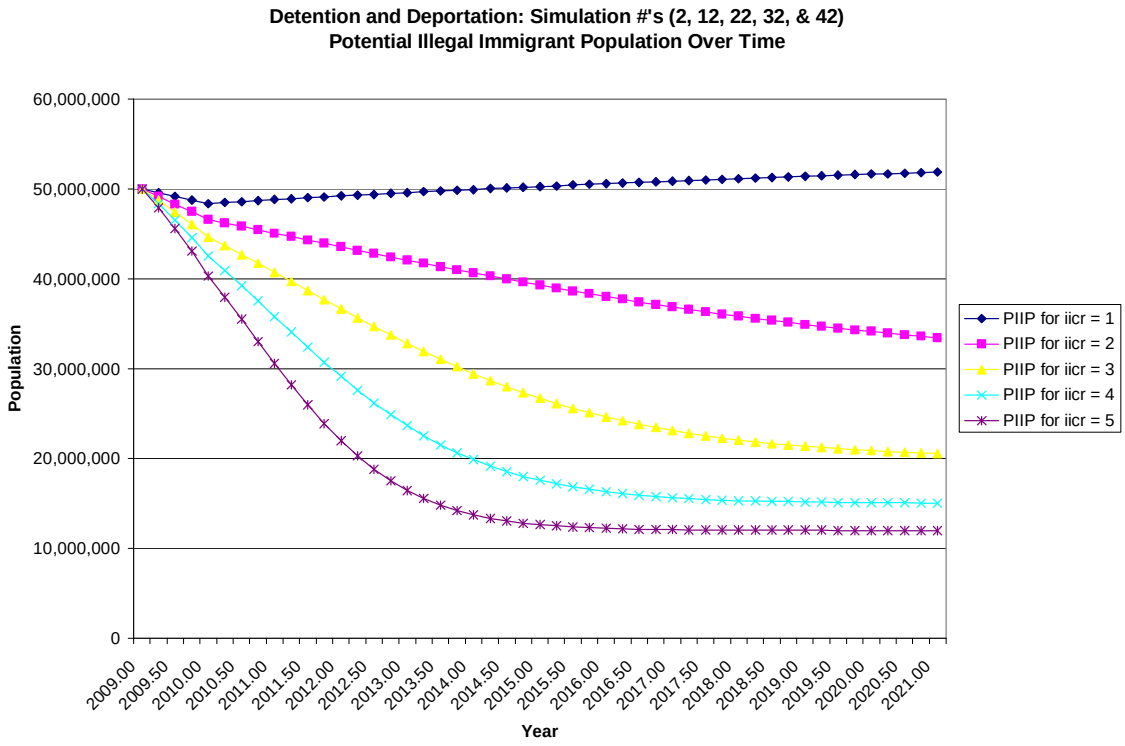
IX.1 A

Table 1

Southwest Sector	Other Sectors
San Diego, CA	Blaine, WA
El Centro, CA	. Buffalo, NY
Yuma, AZ	Detroit, MI
Tucson, AZ	Grand Forks, ND
El Paso, TX	Havre, MT
Marfa, TX	Houlton, ME
Del Rio, TX	Livermore, CA
Laredo, TX	Miami, FL
Rio Grande Valley, TX	New Orleans, LA
	Ramey, PR
	Spokane, WA
	Swanton, VT

IX.2 B

Chart 1



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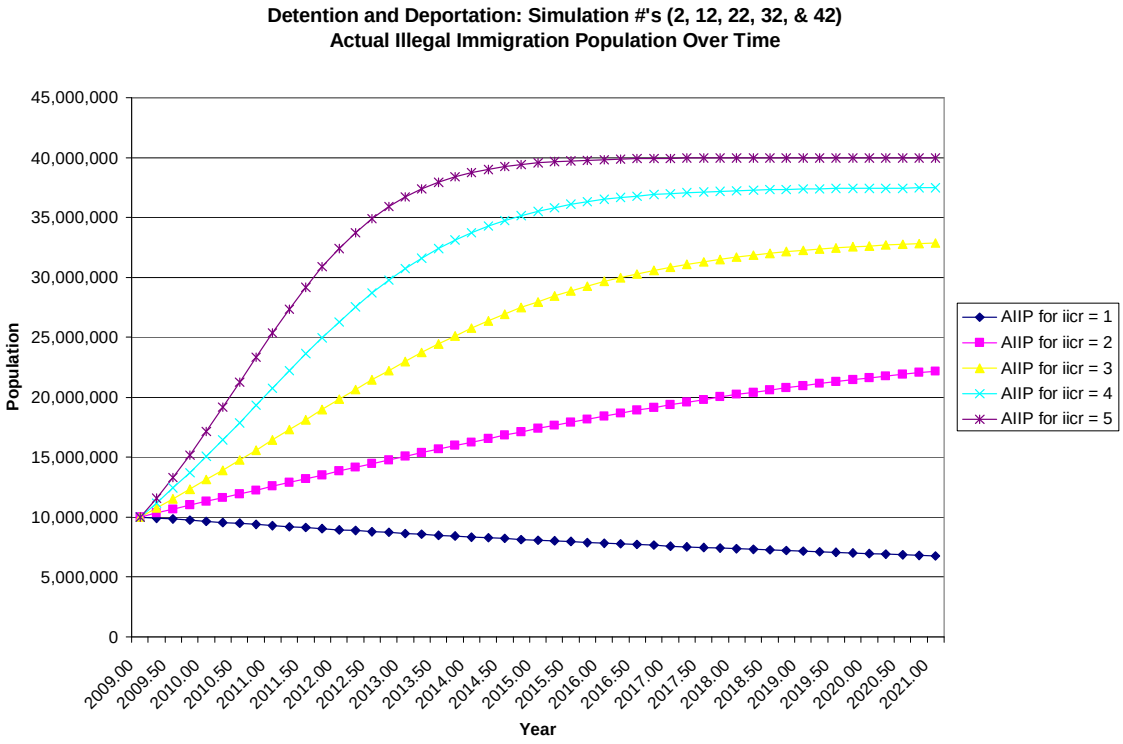

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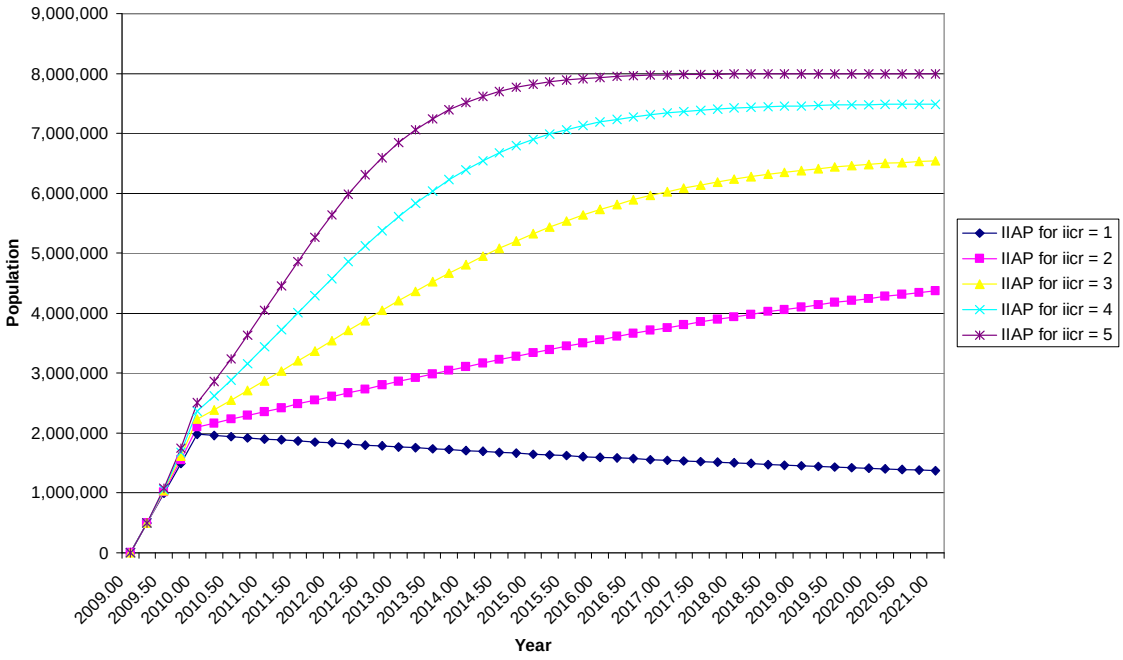

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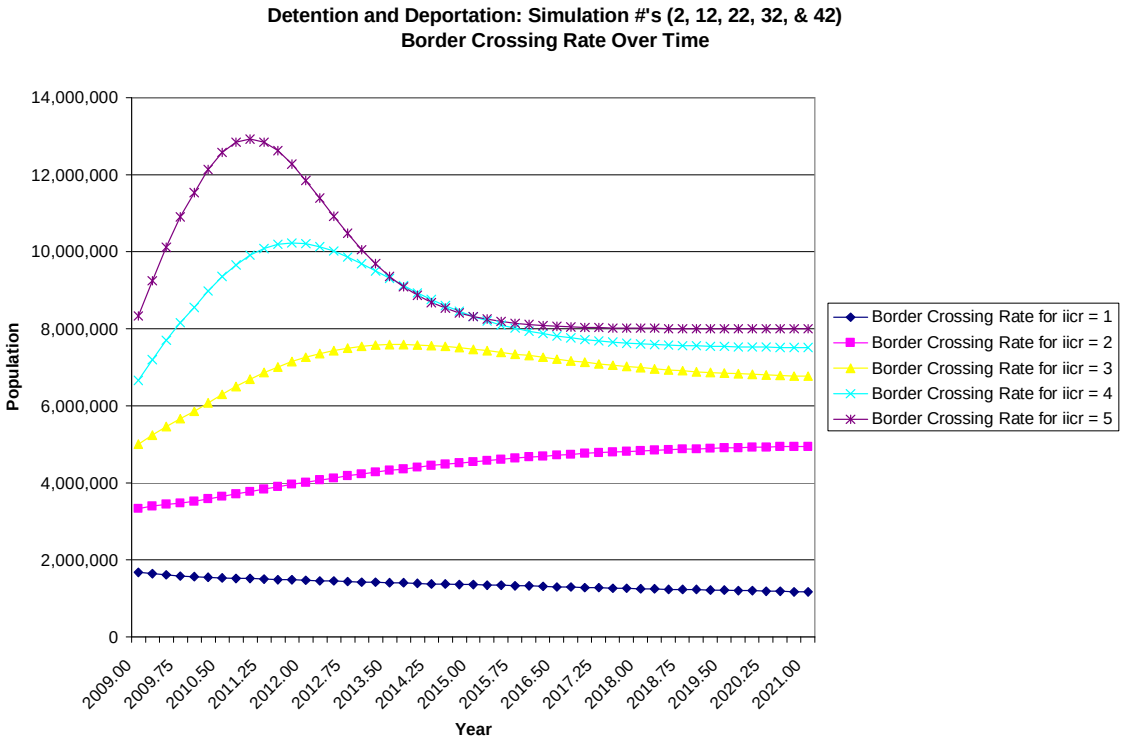

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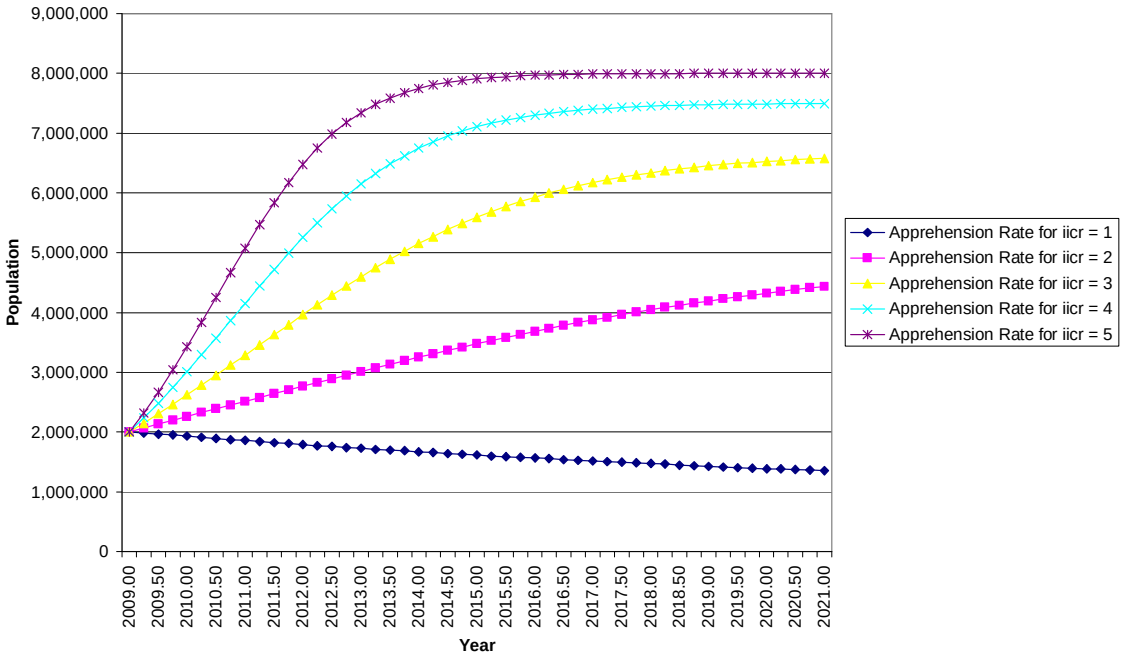

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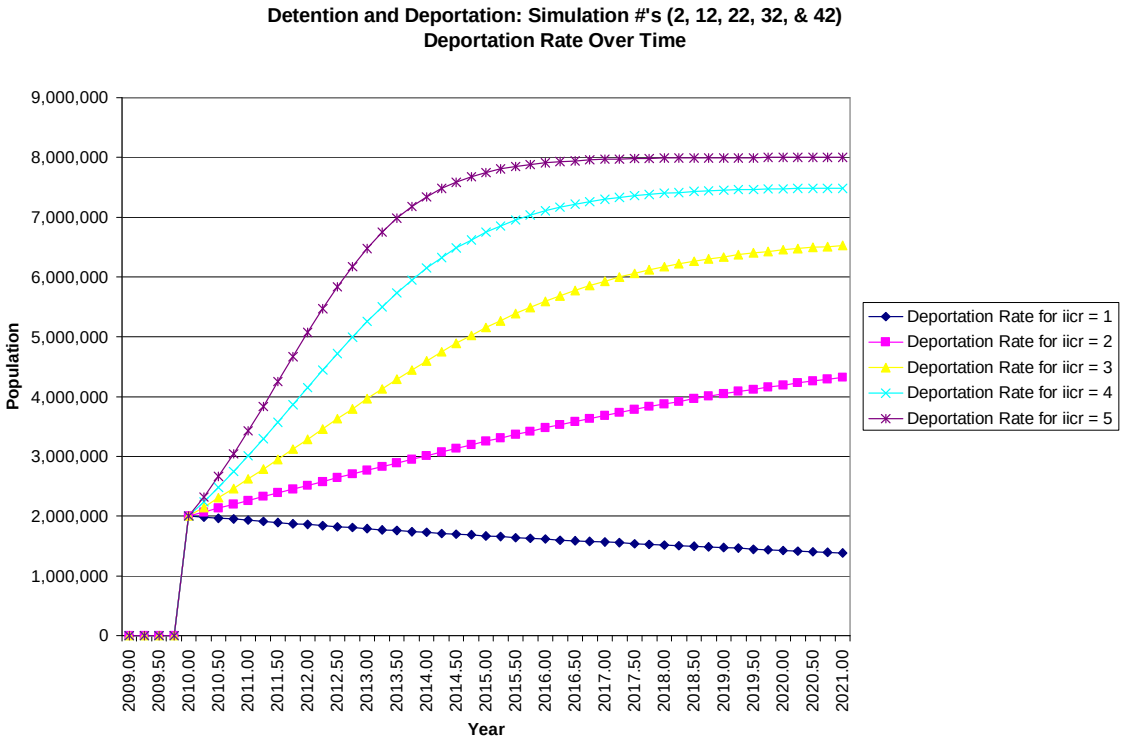

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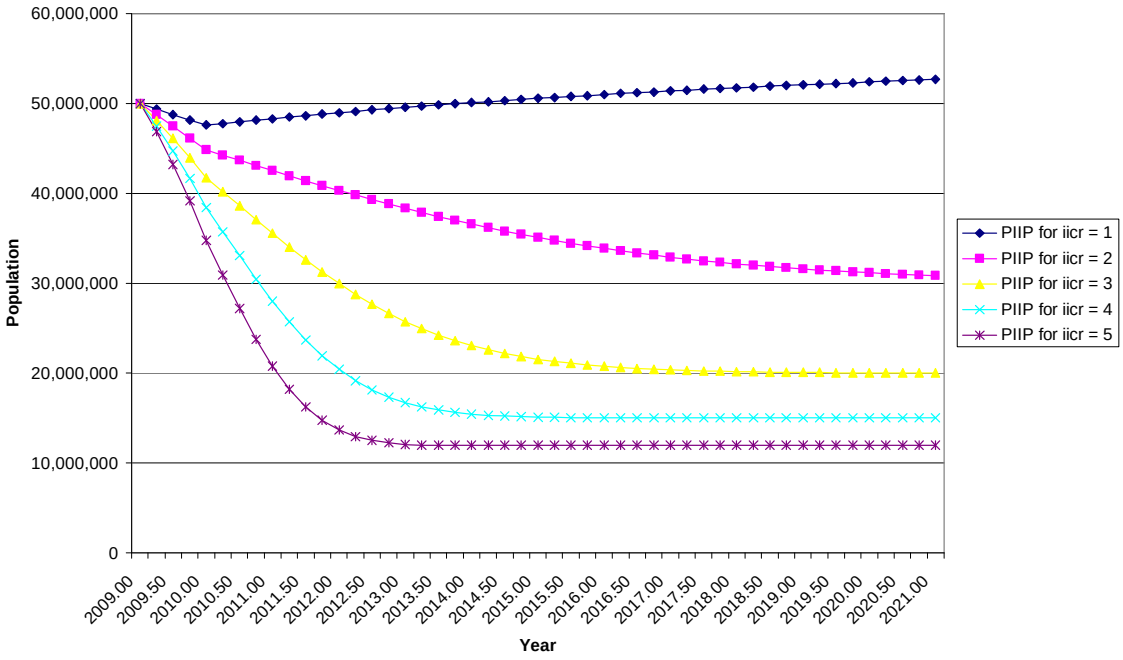


Chart 8

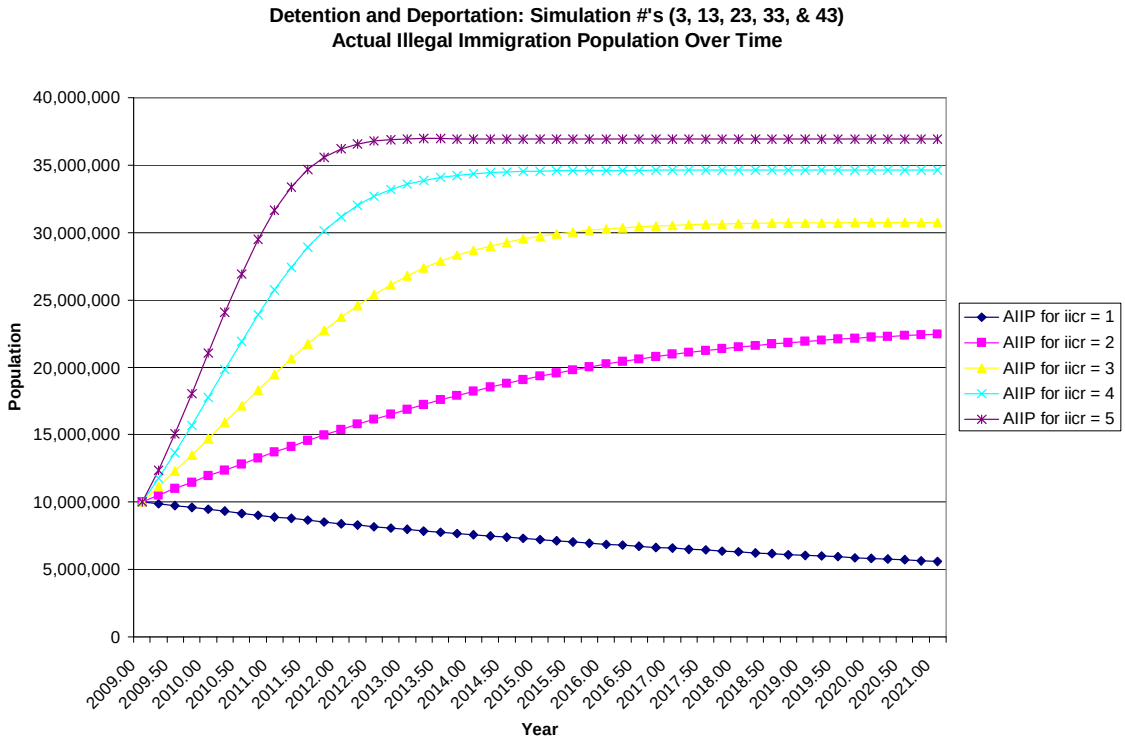
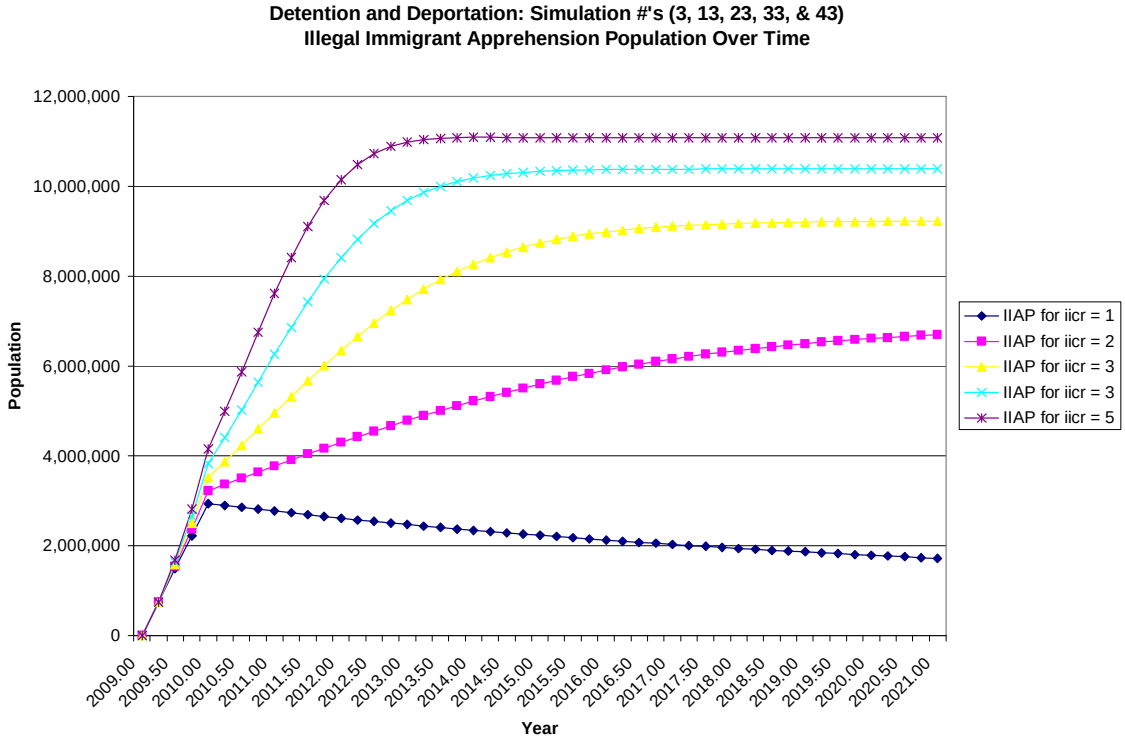


Chart 9



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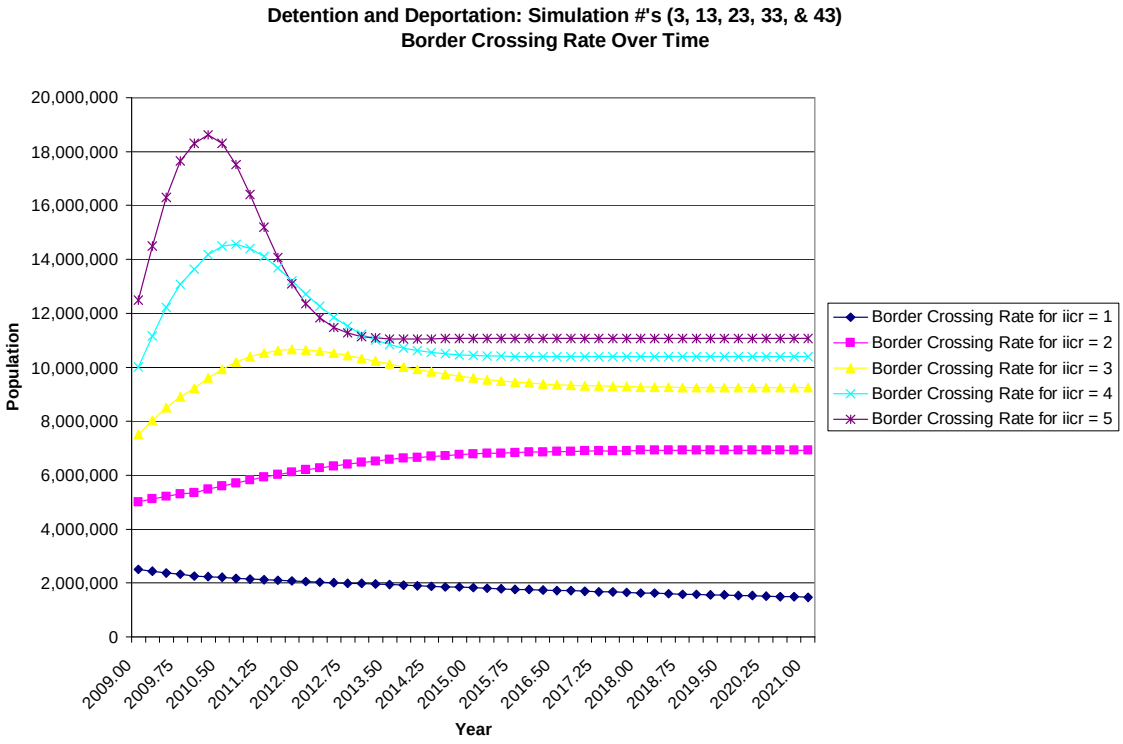

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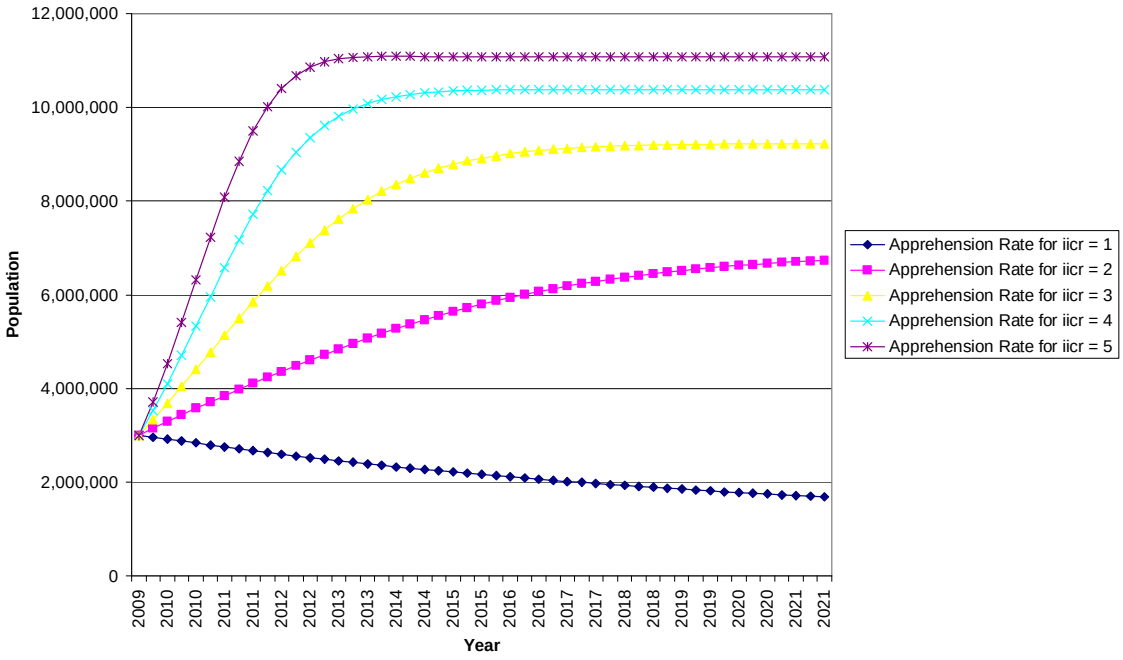

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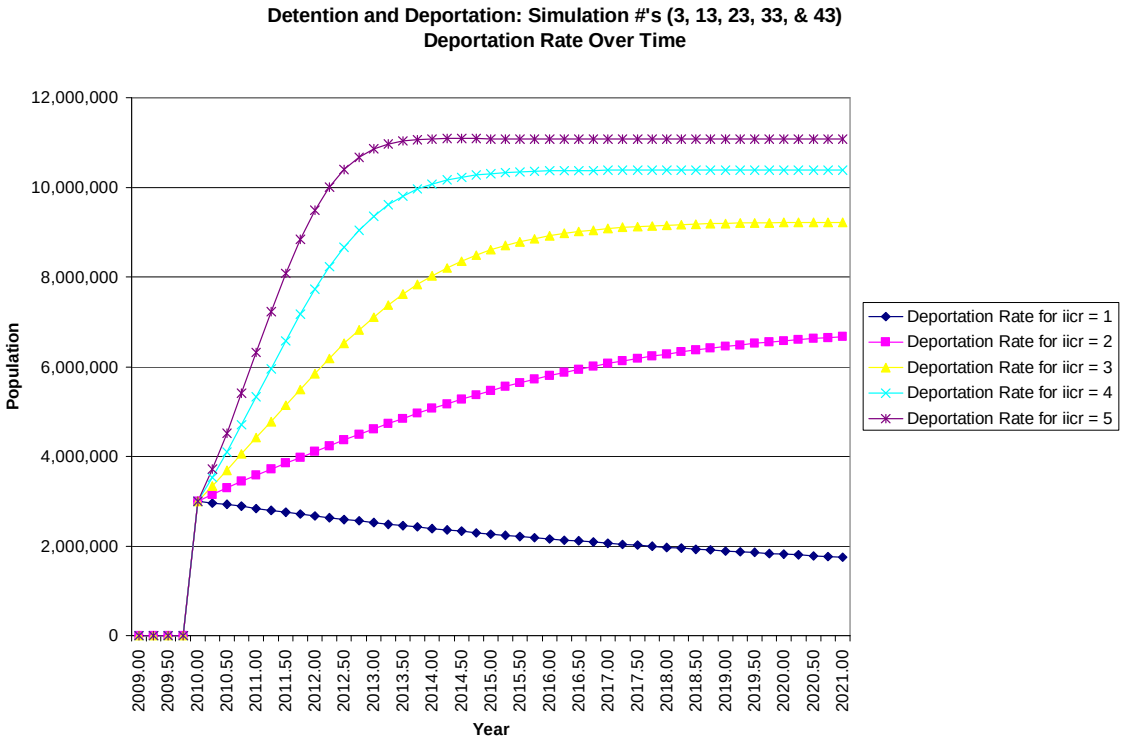

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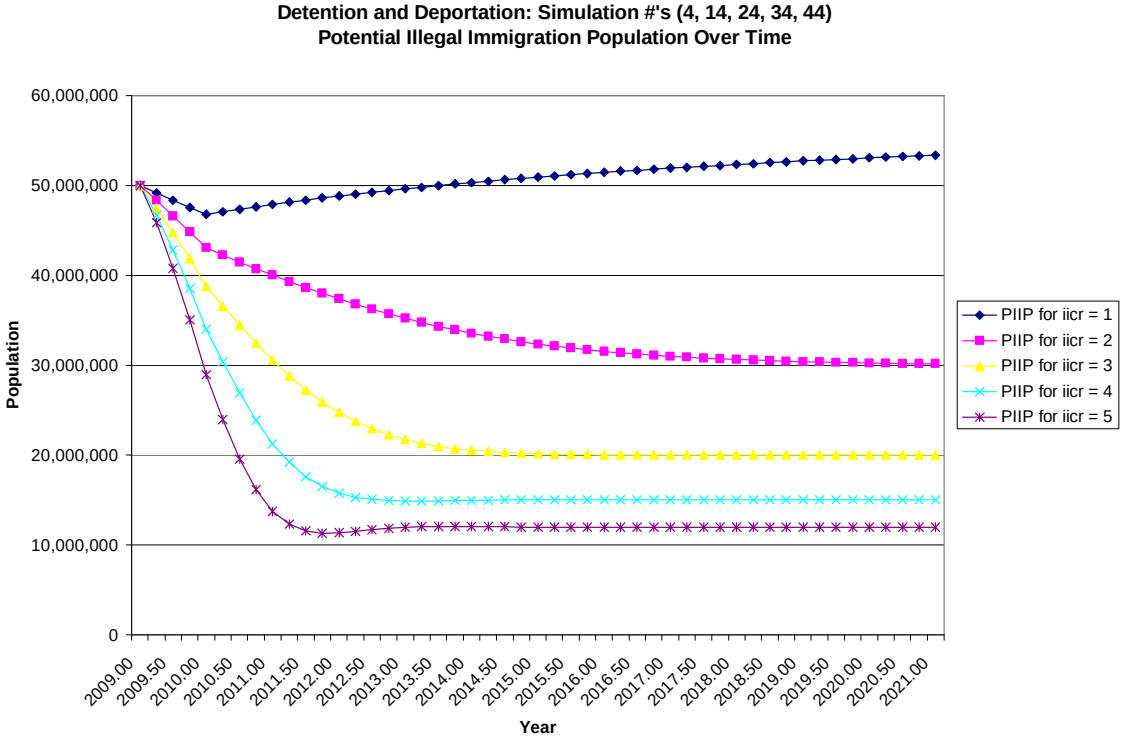

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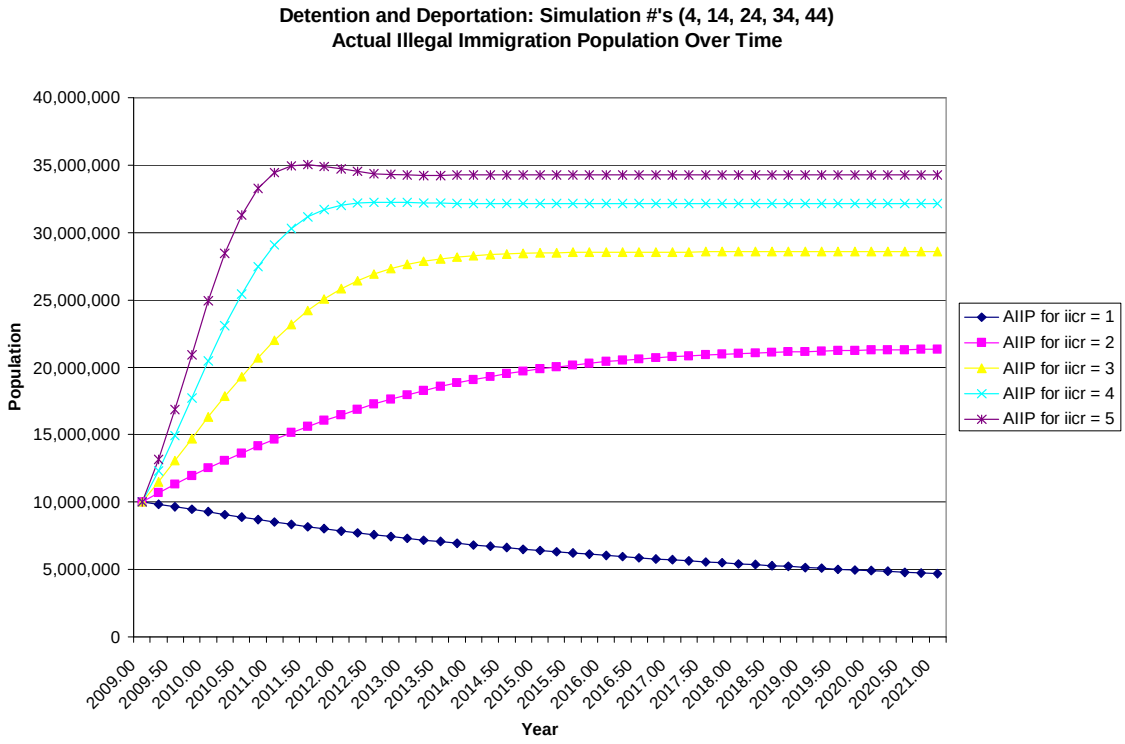

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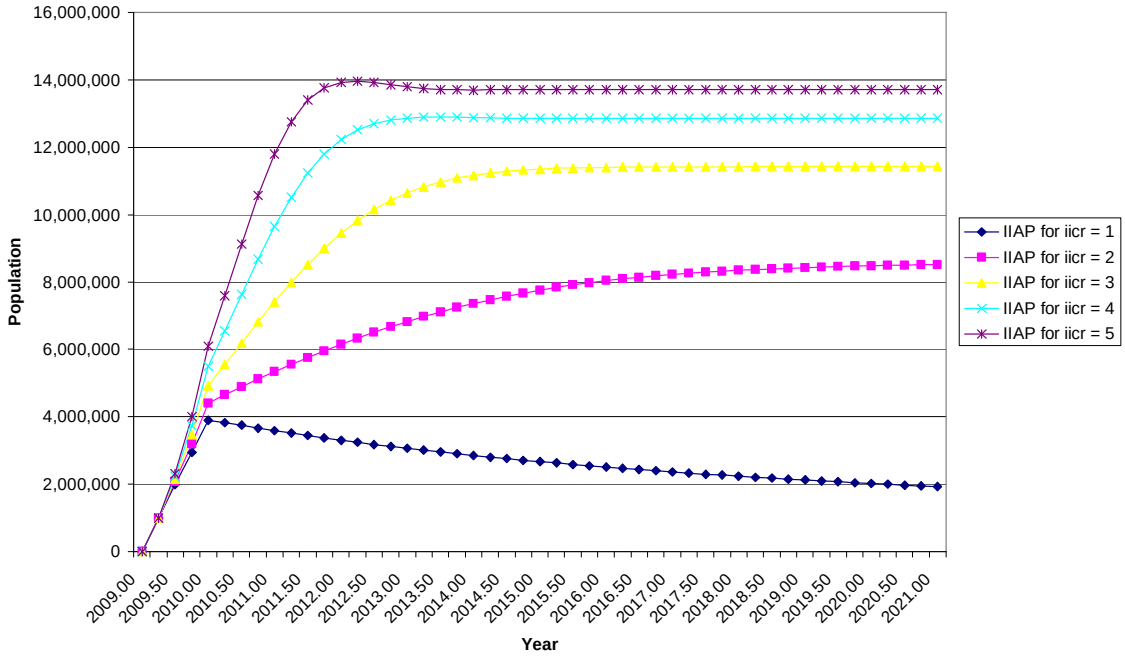

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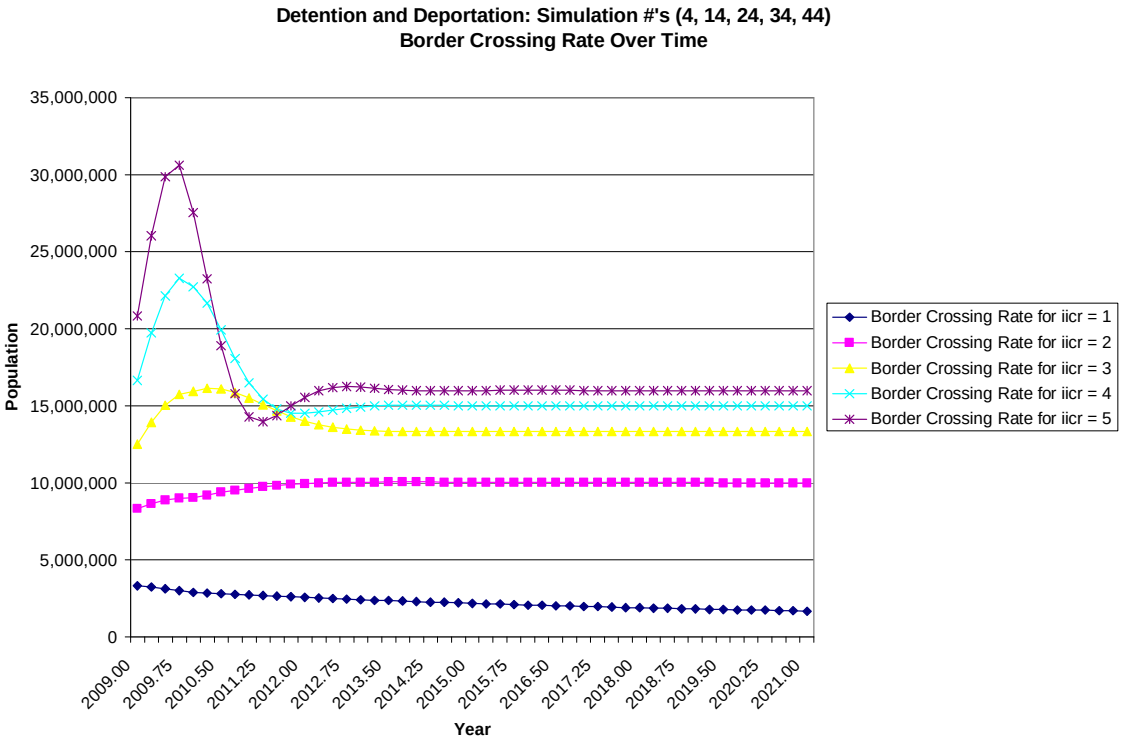

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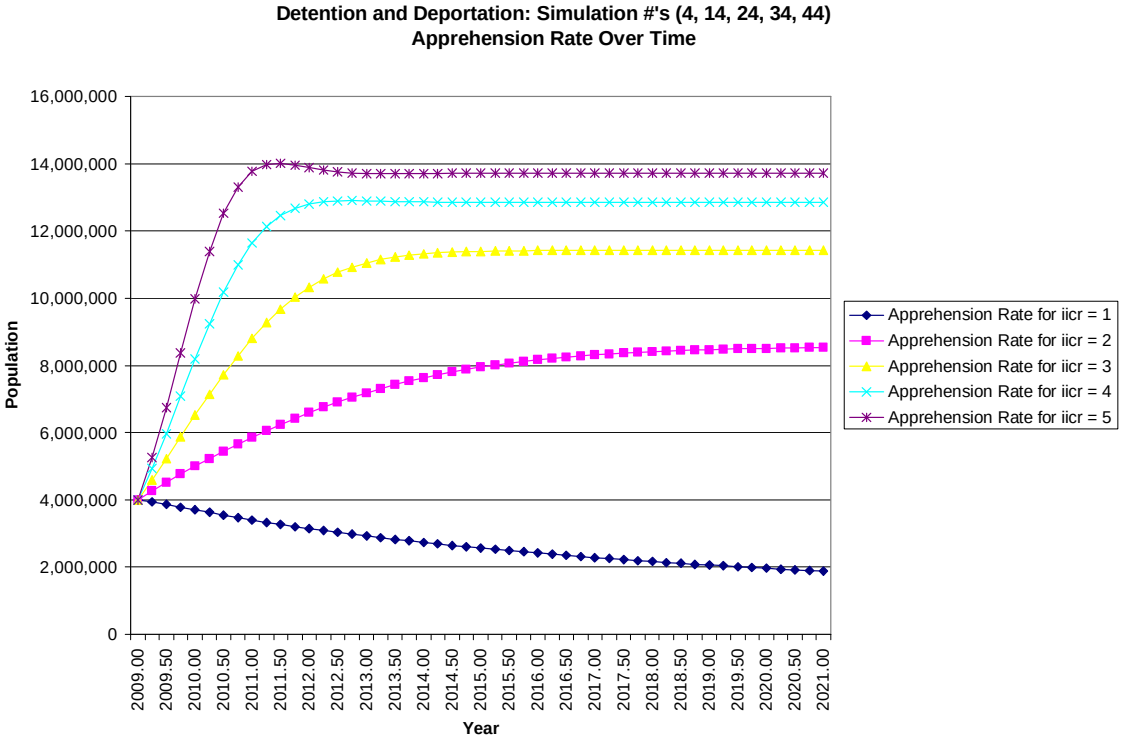

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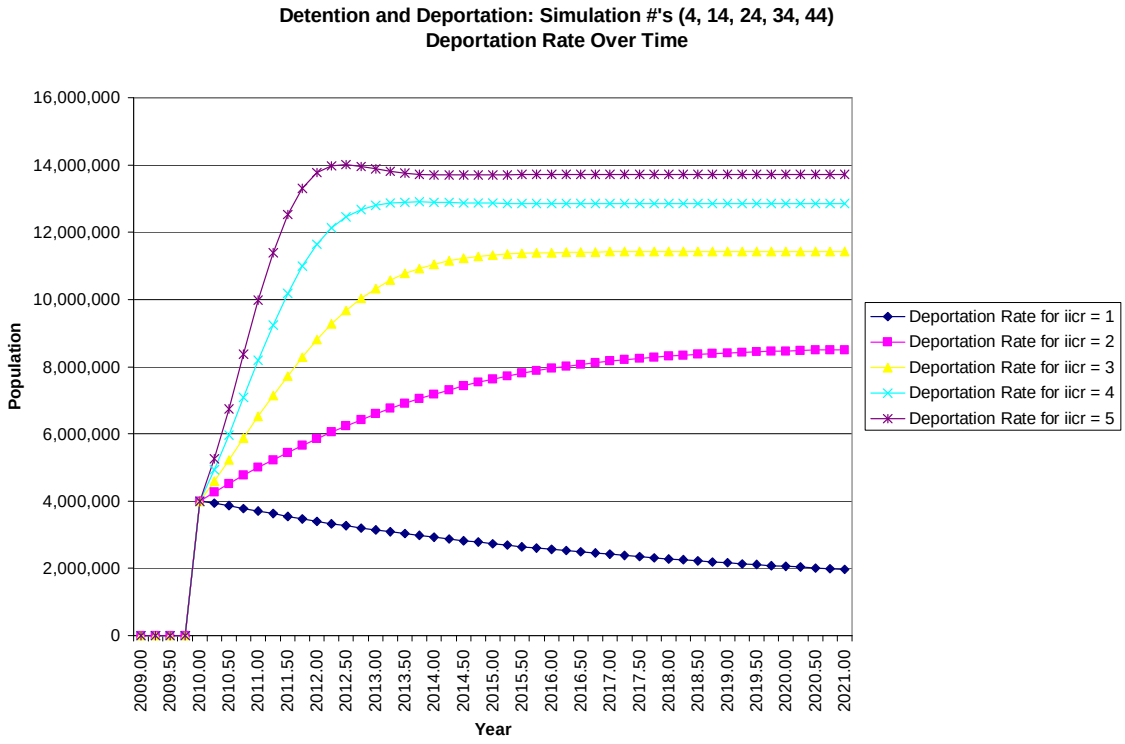

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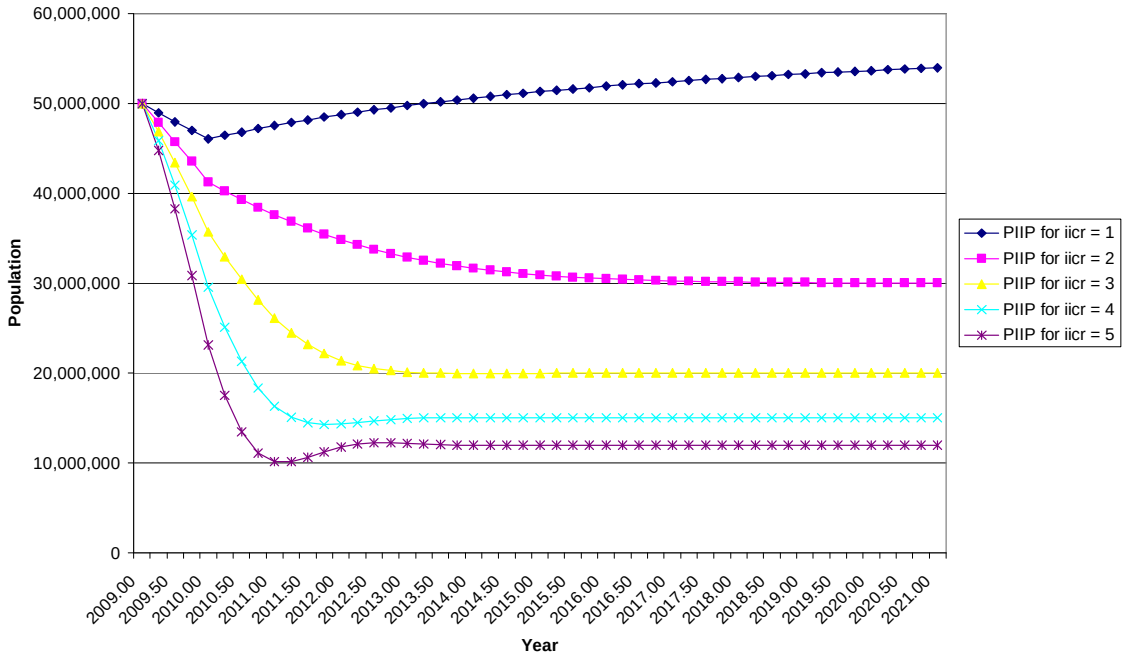

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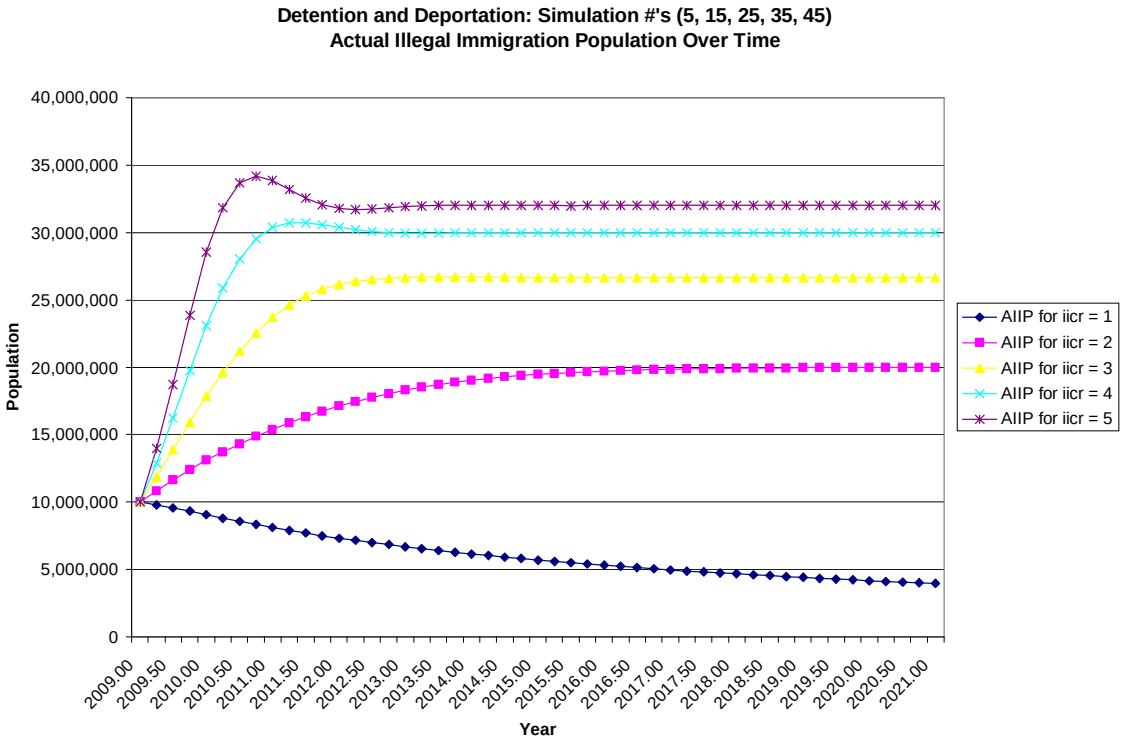

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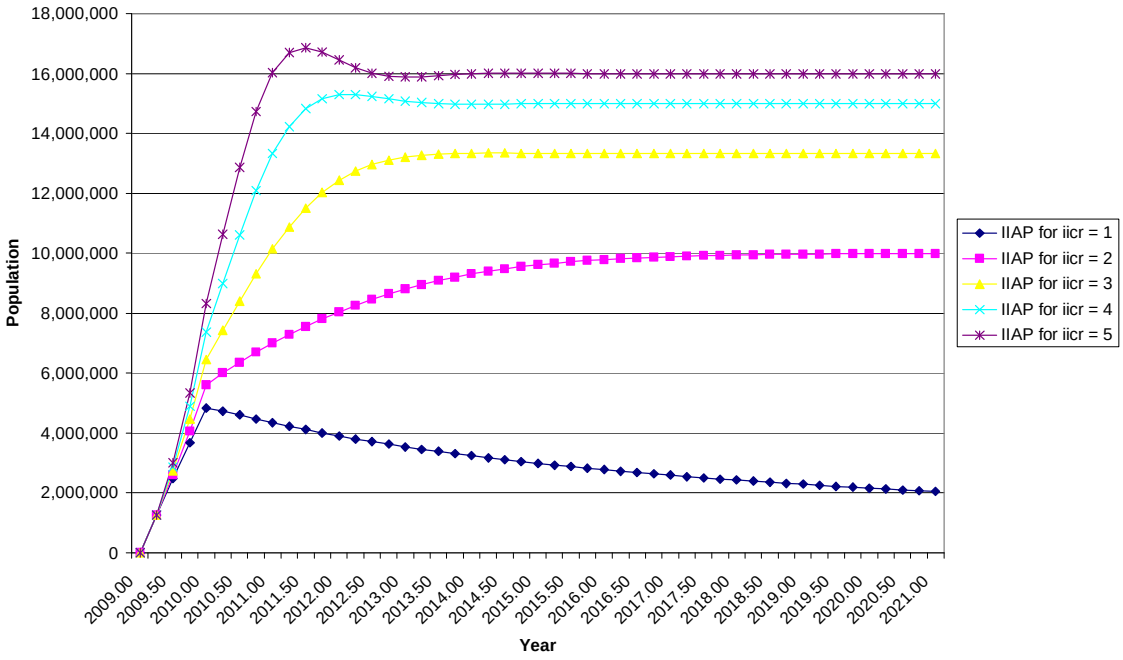

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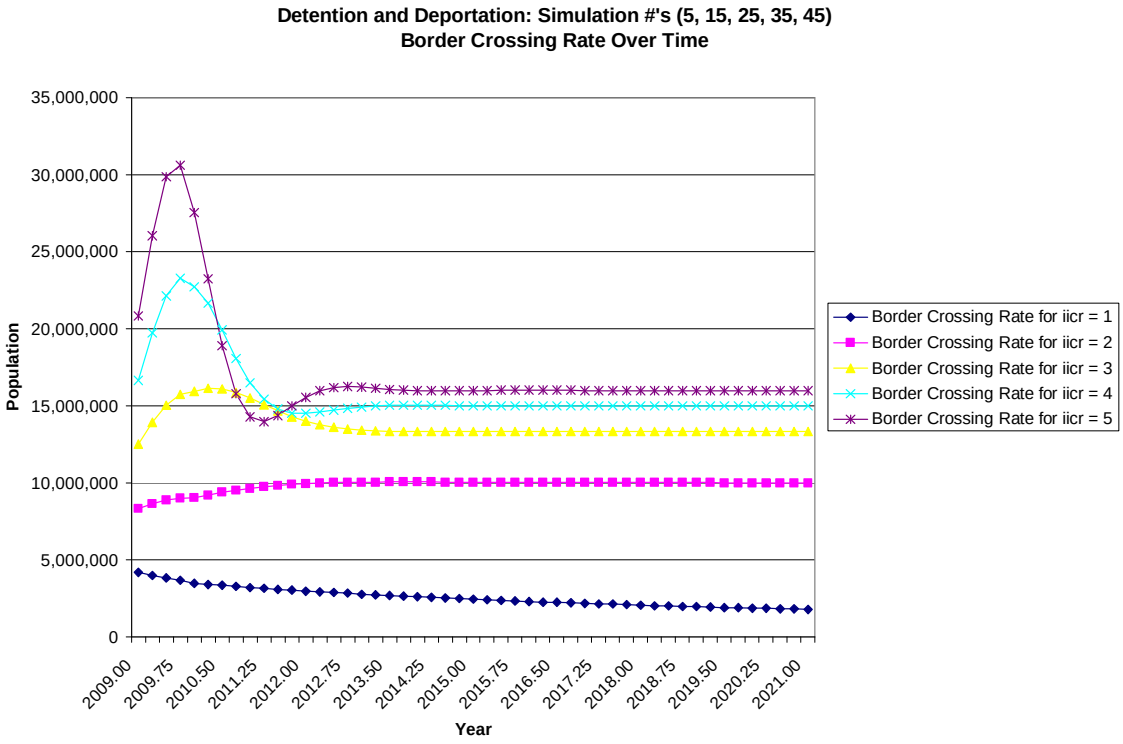

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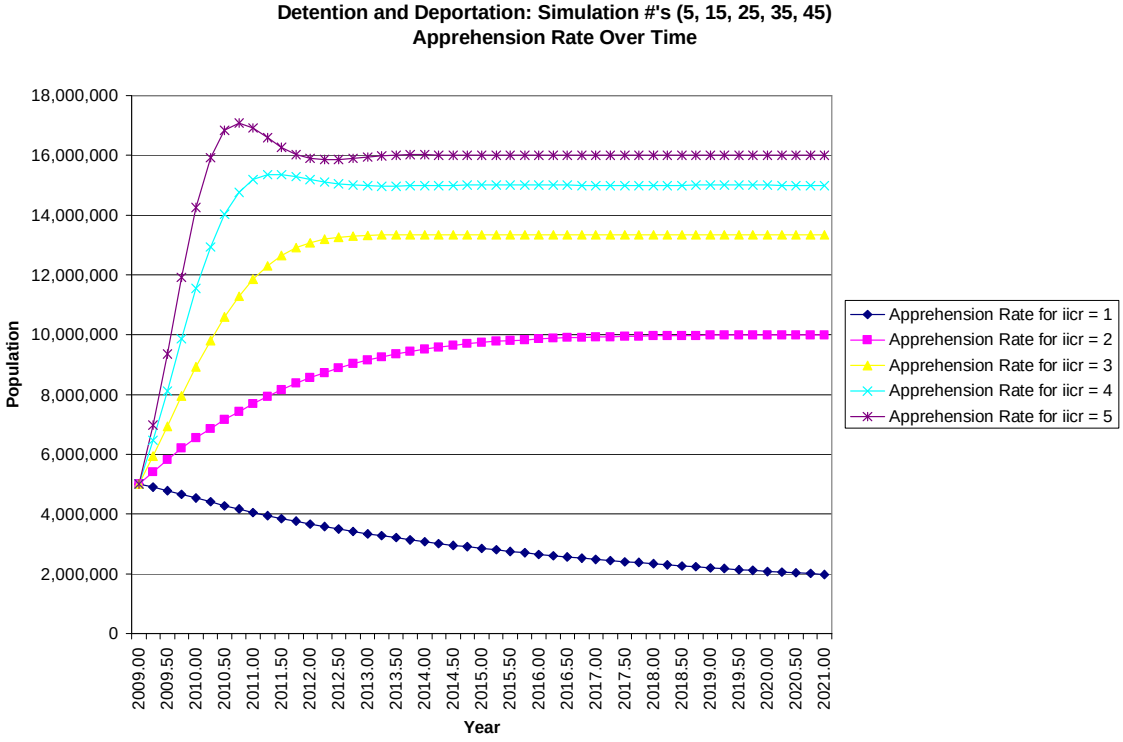

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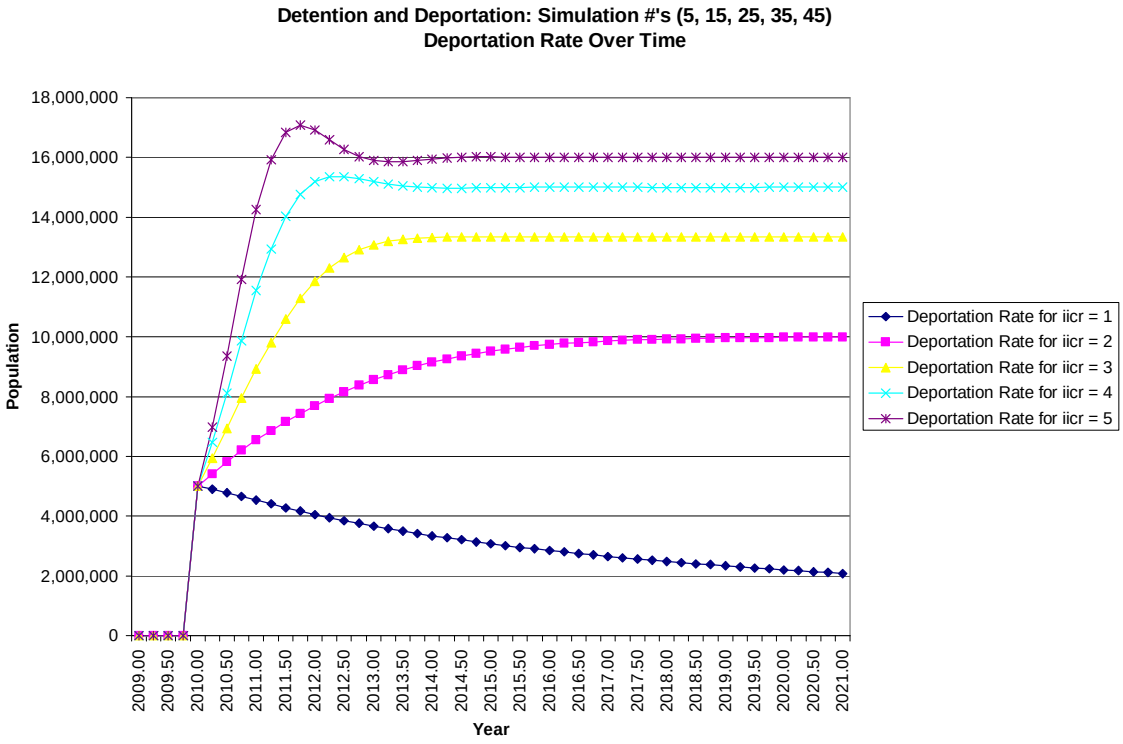

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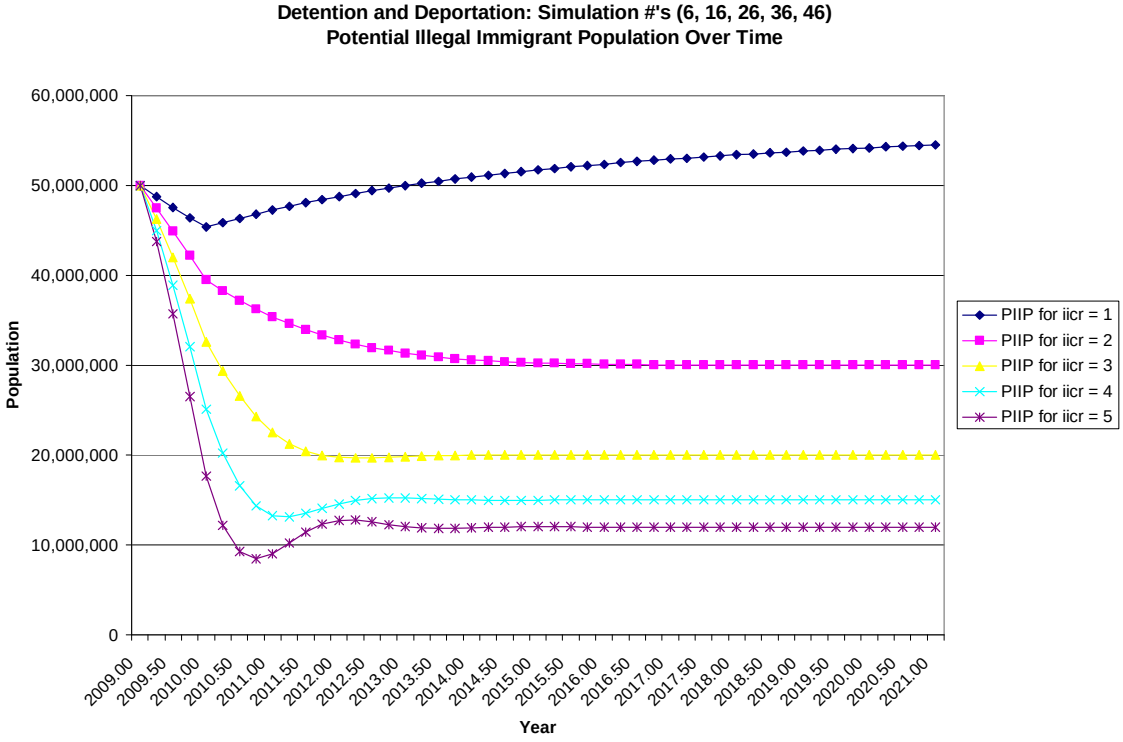

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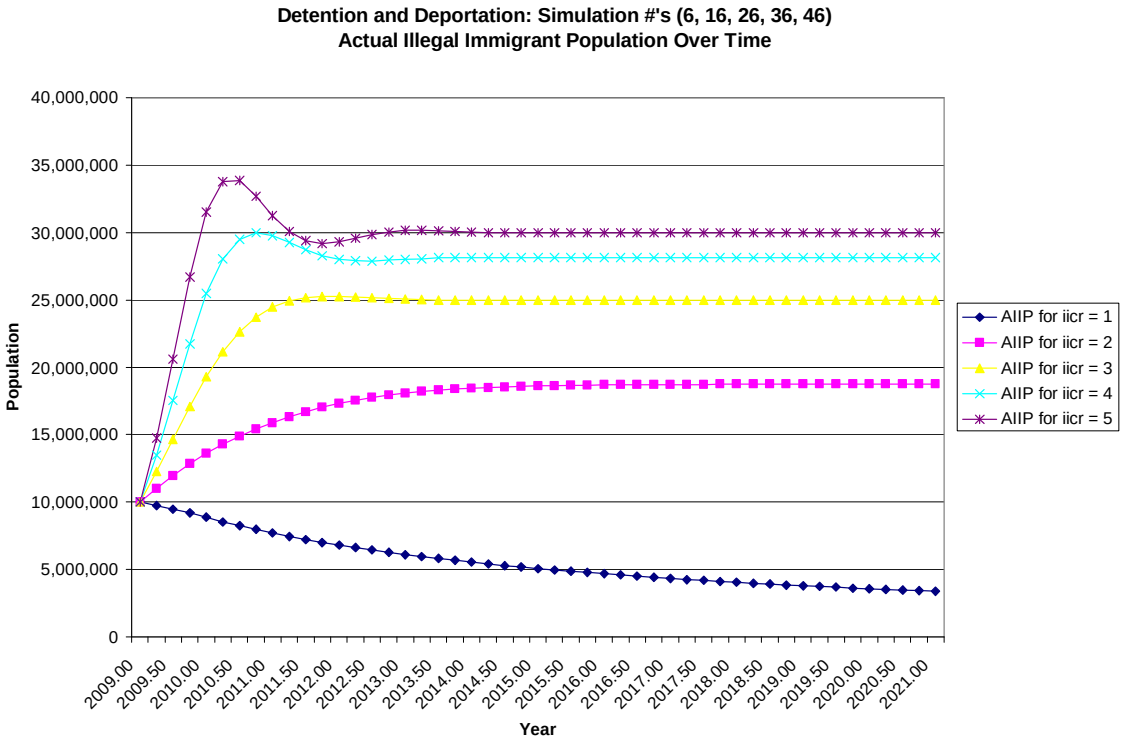

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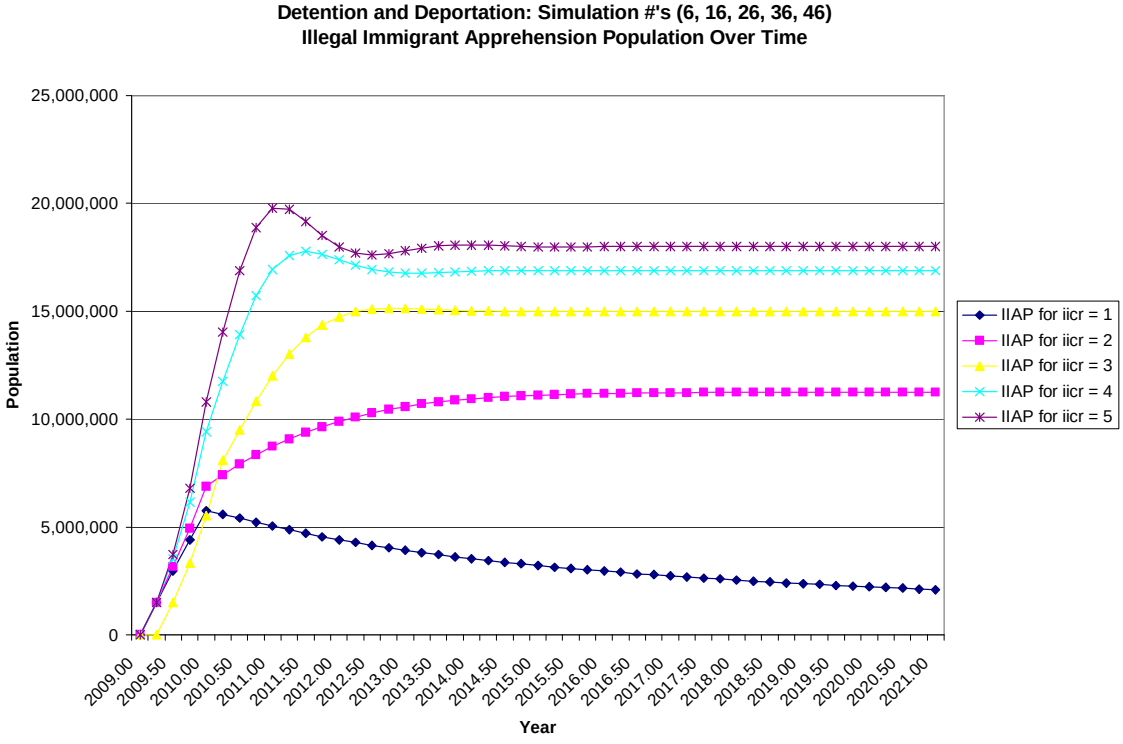

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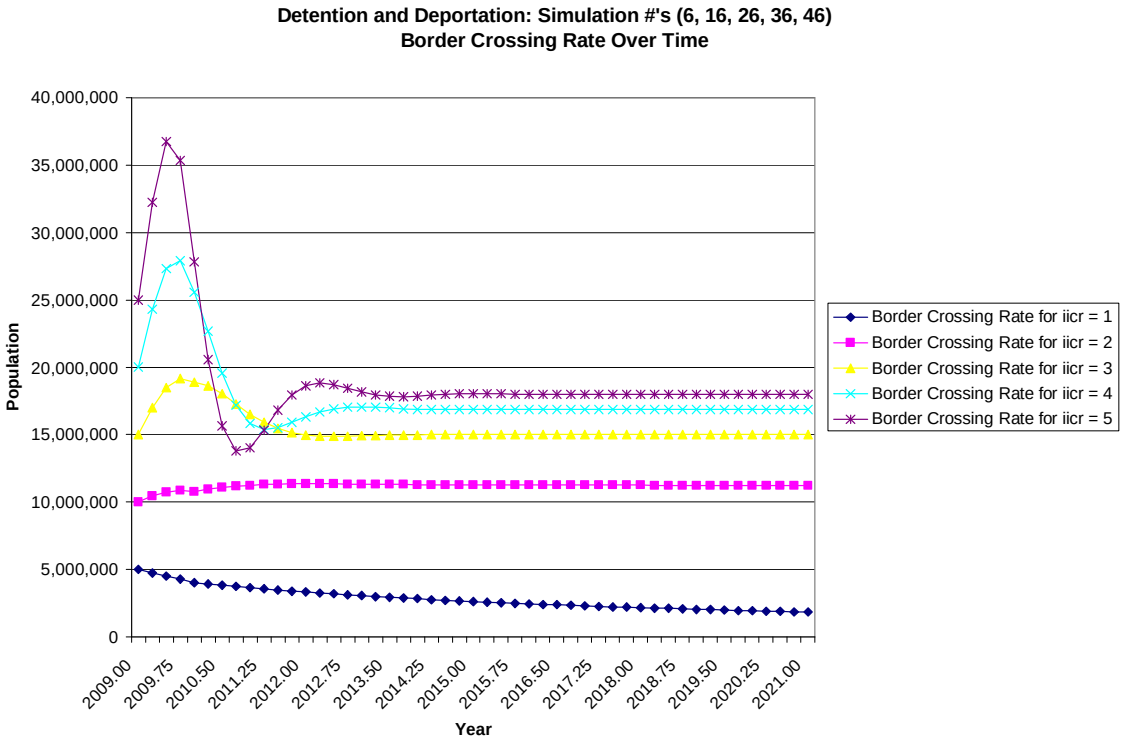

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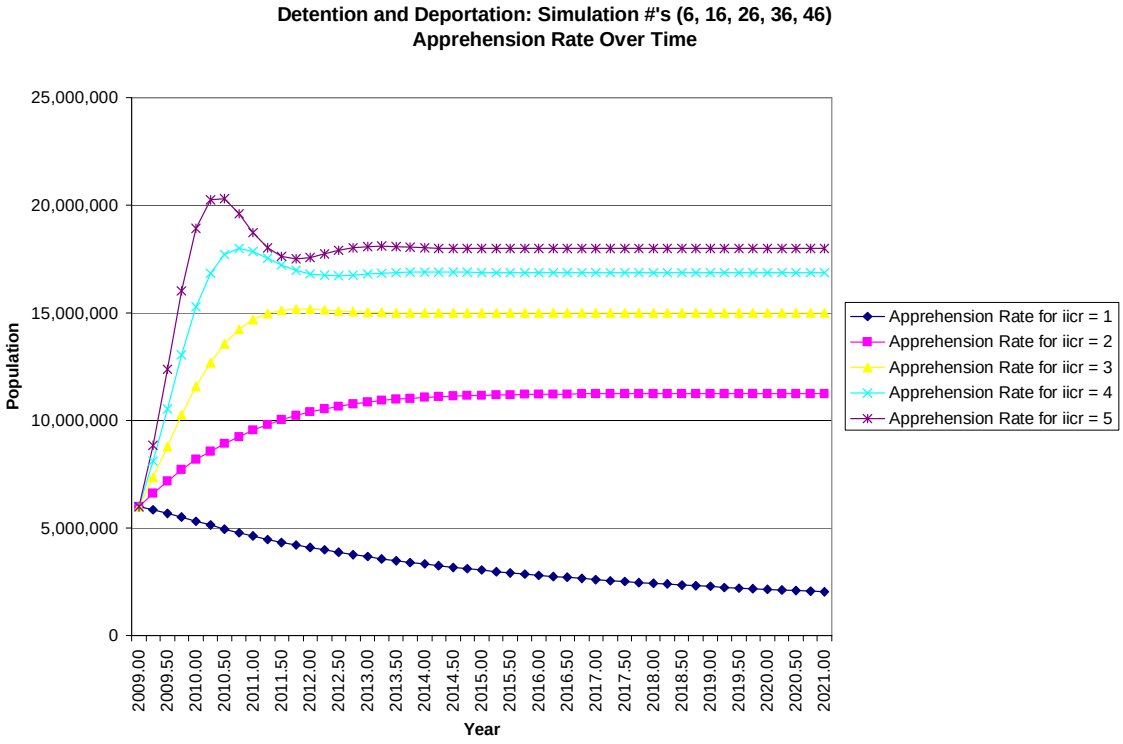

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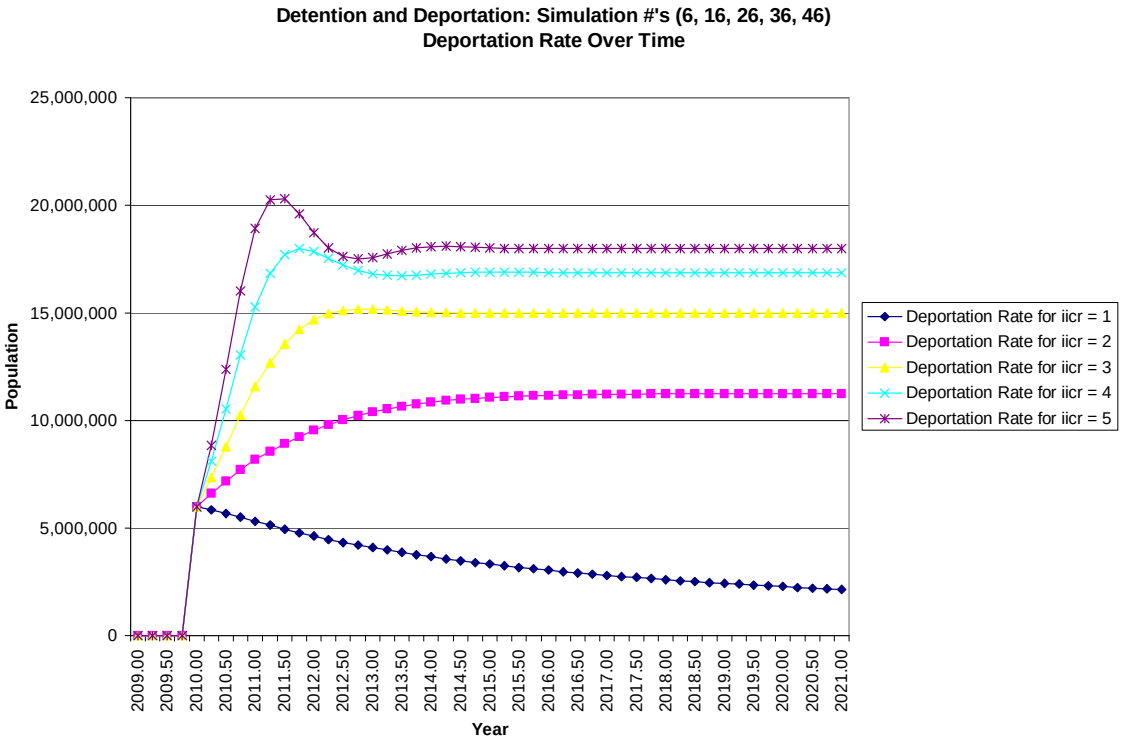

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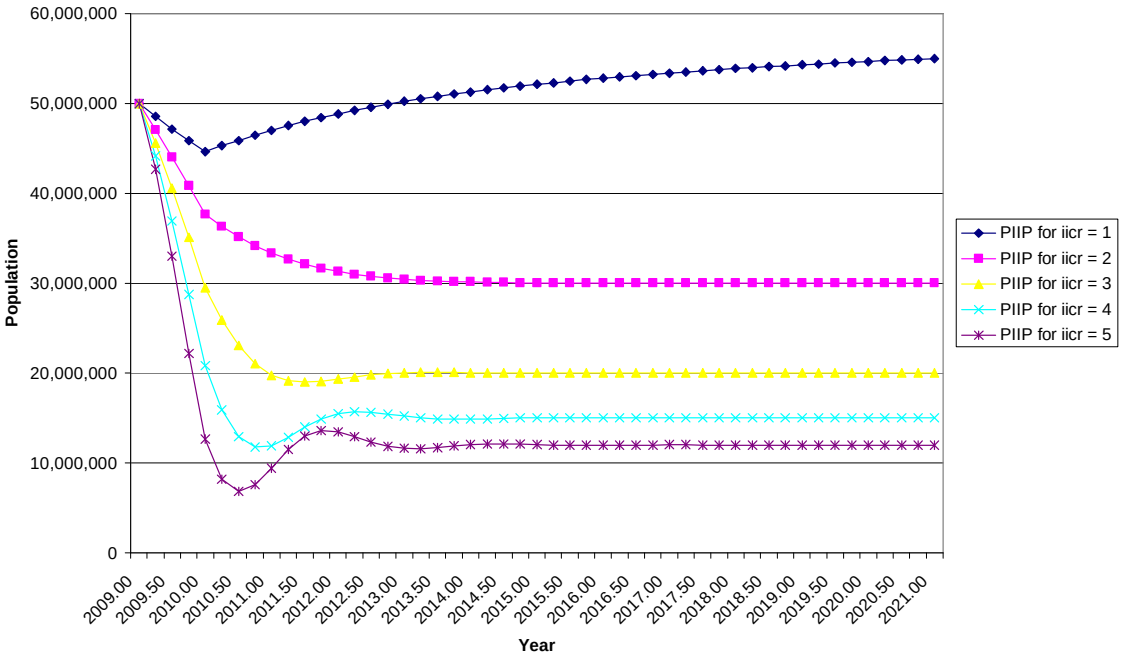

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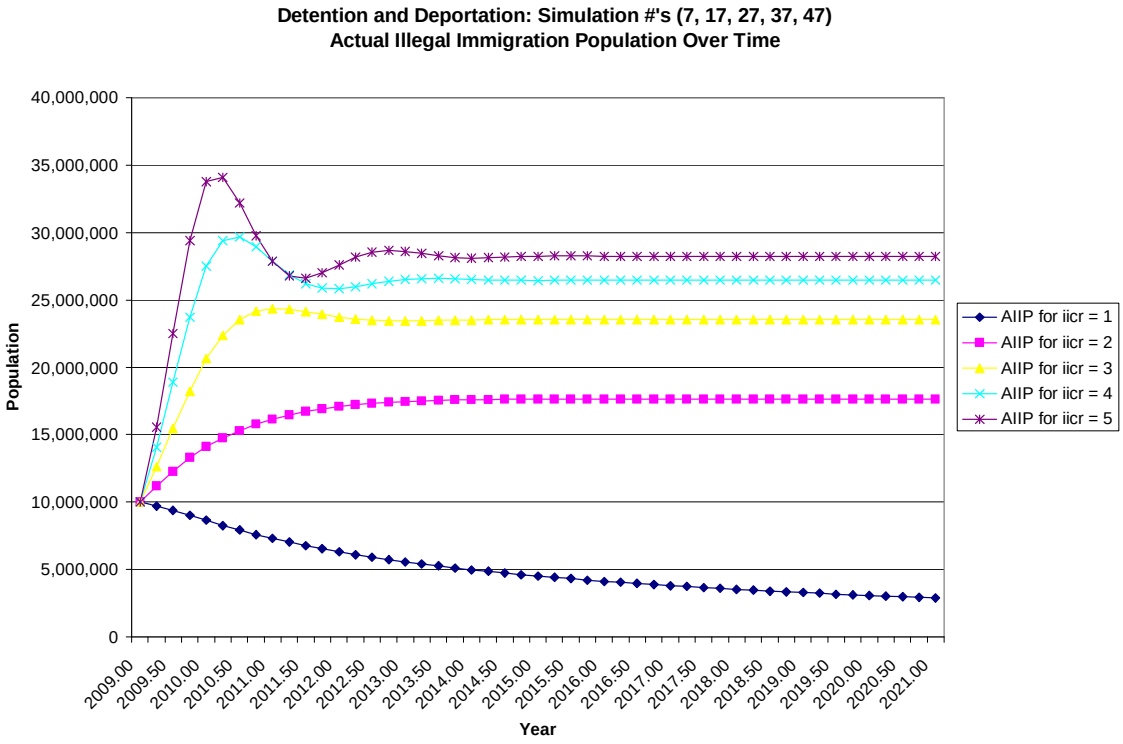

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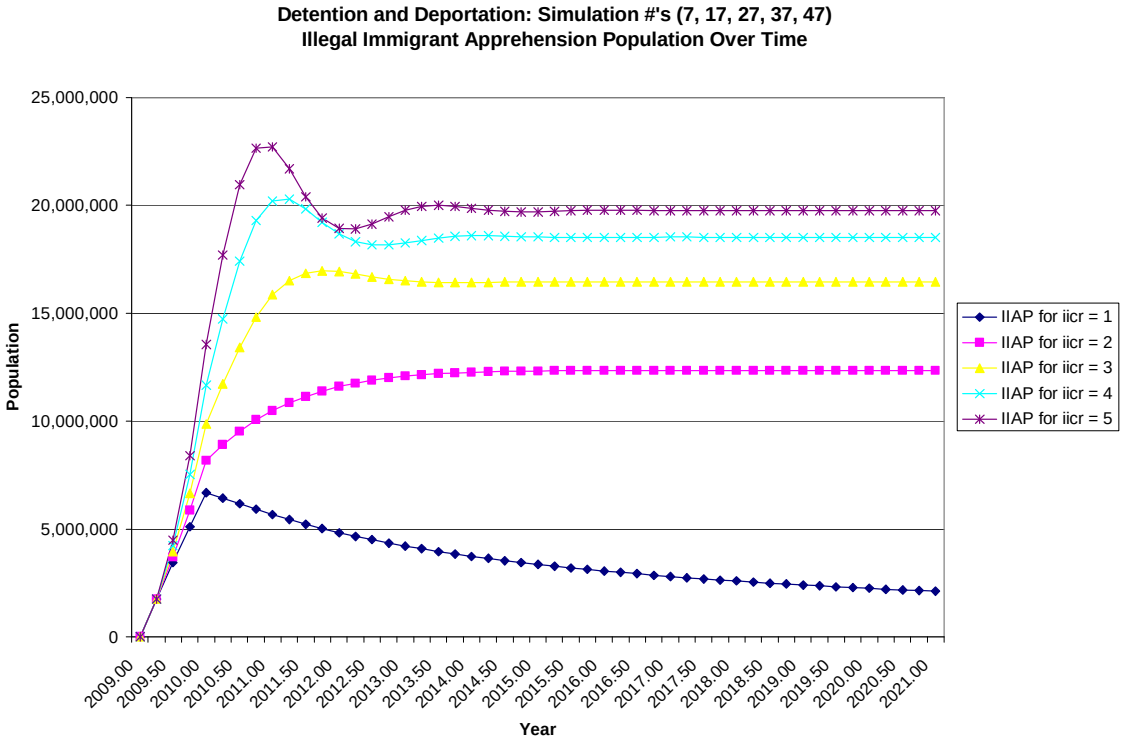

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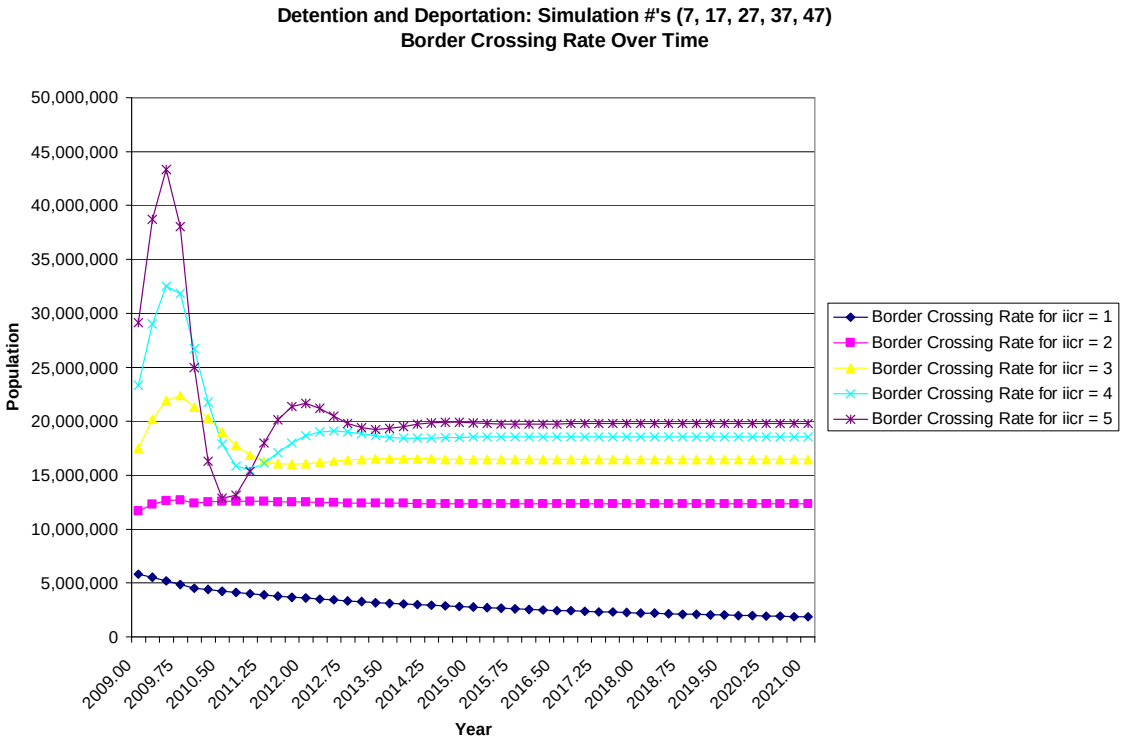

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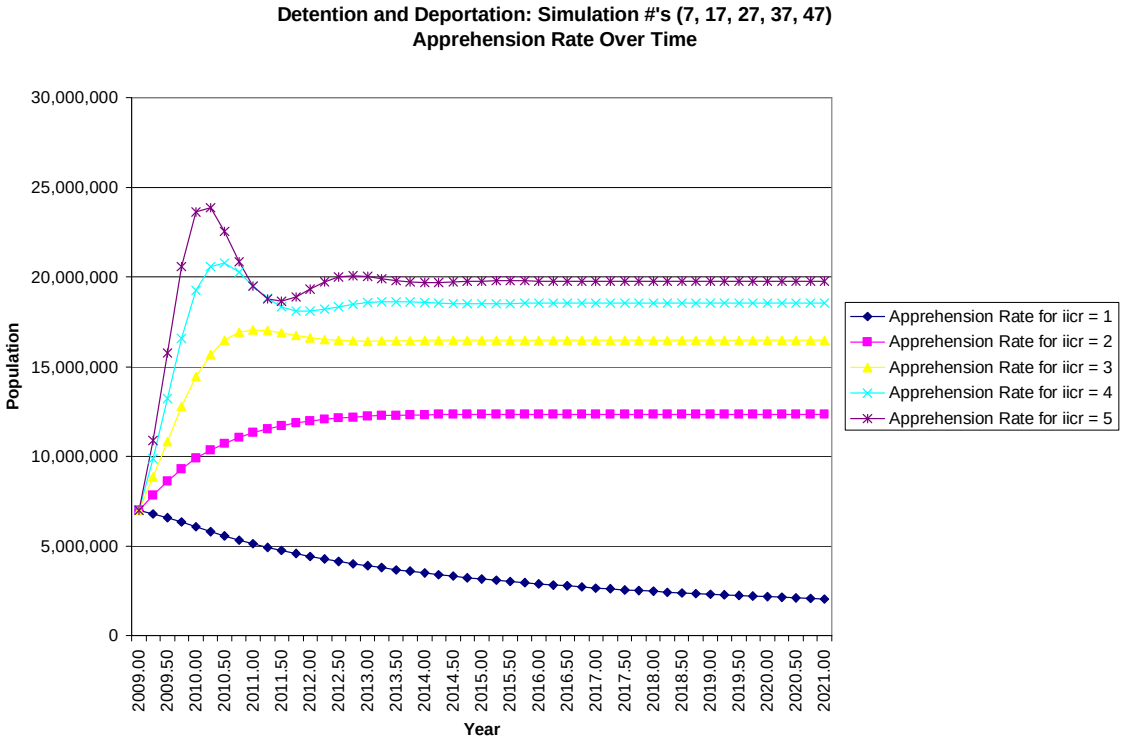

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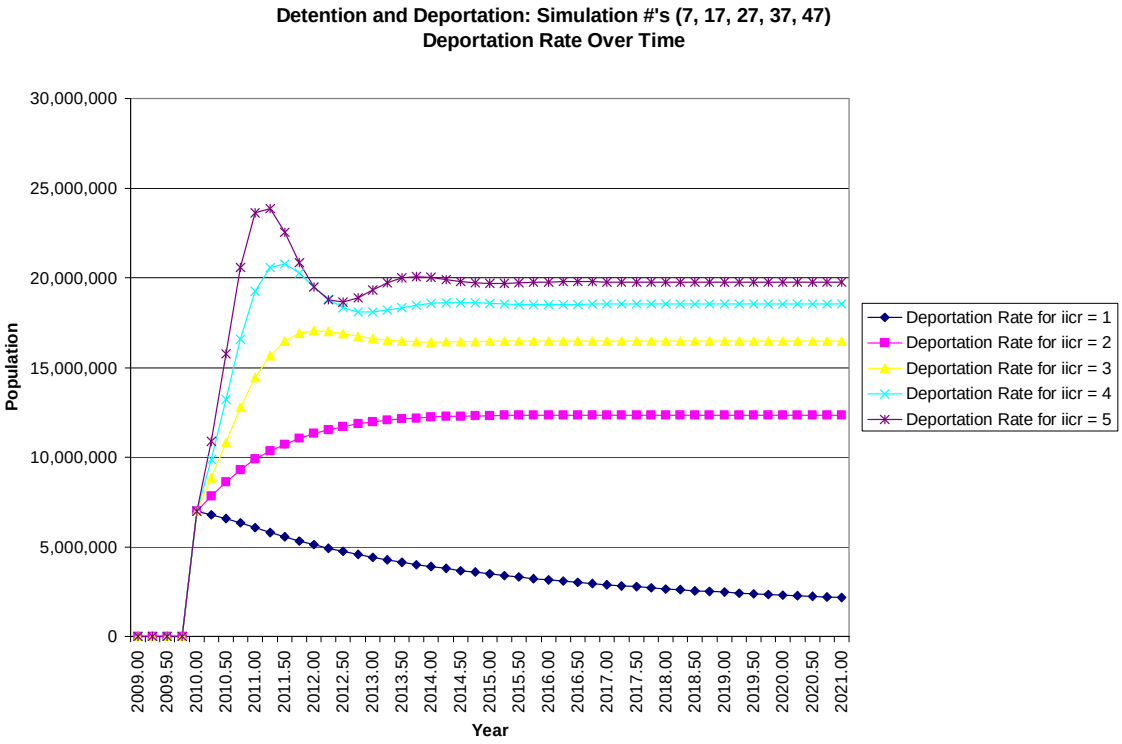

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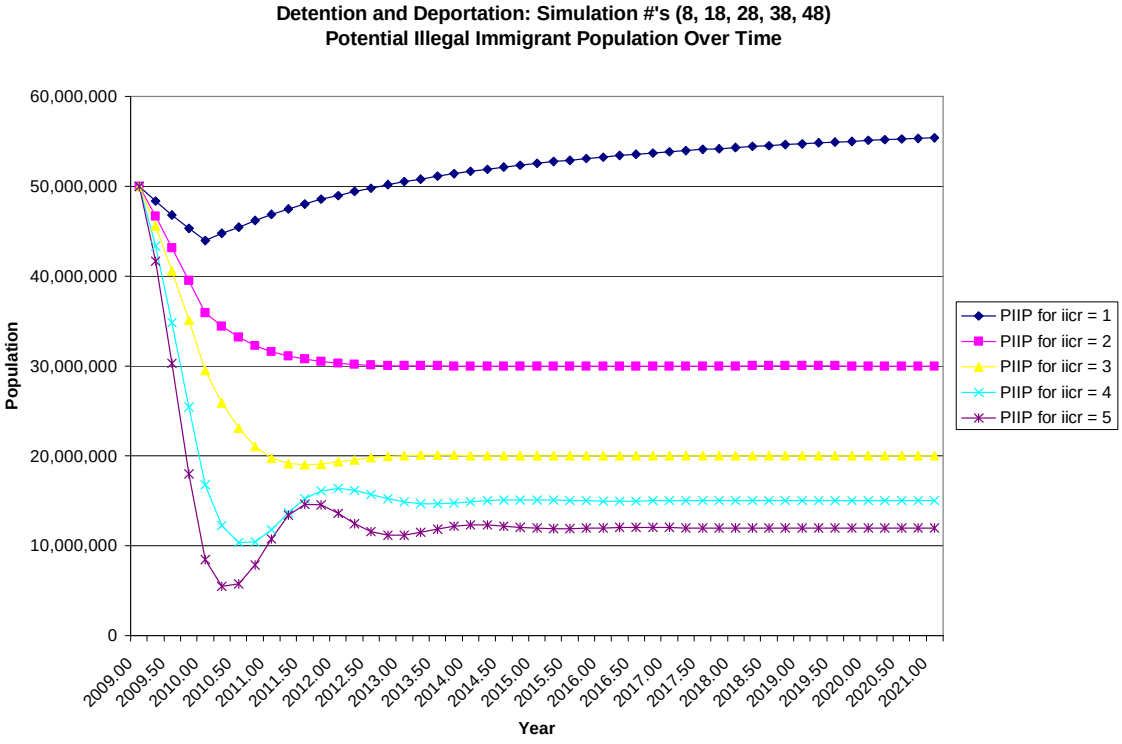

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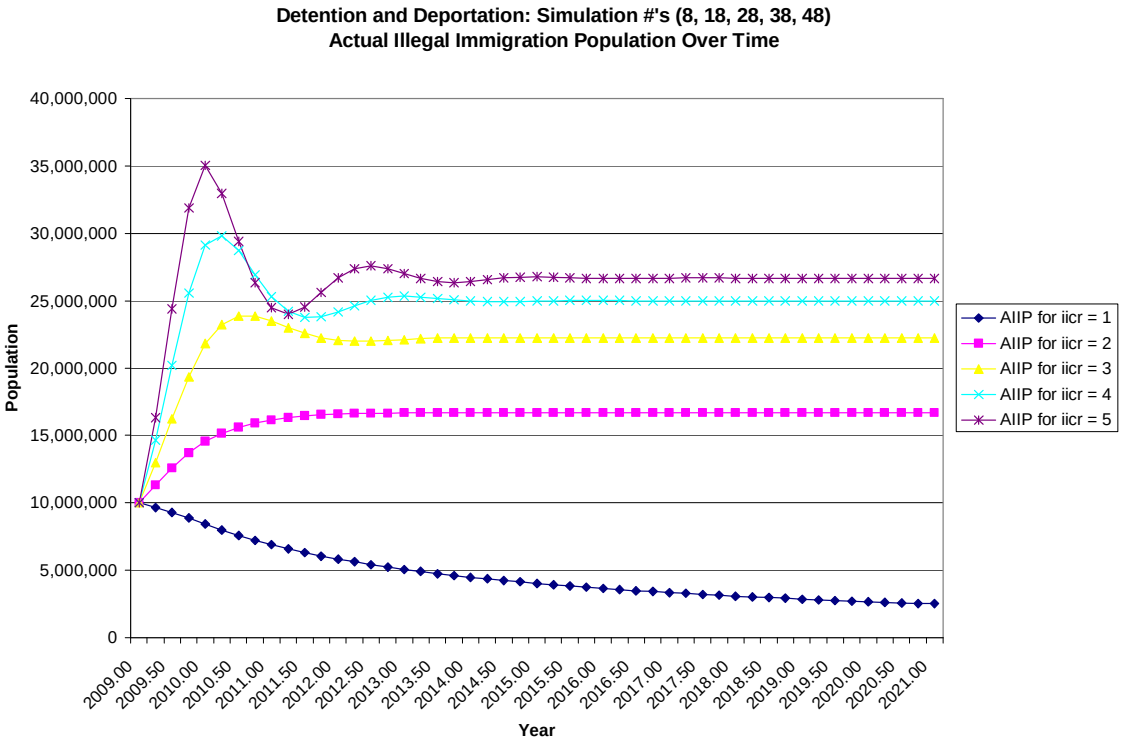

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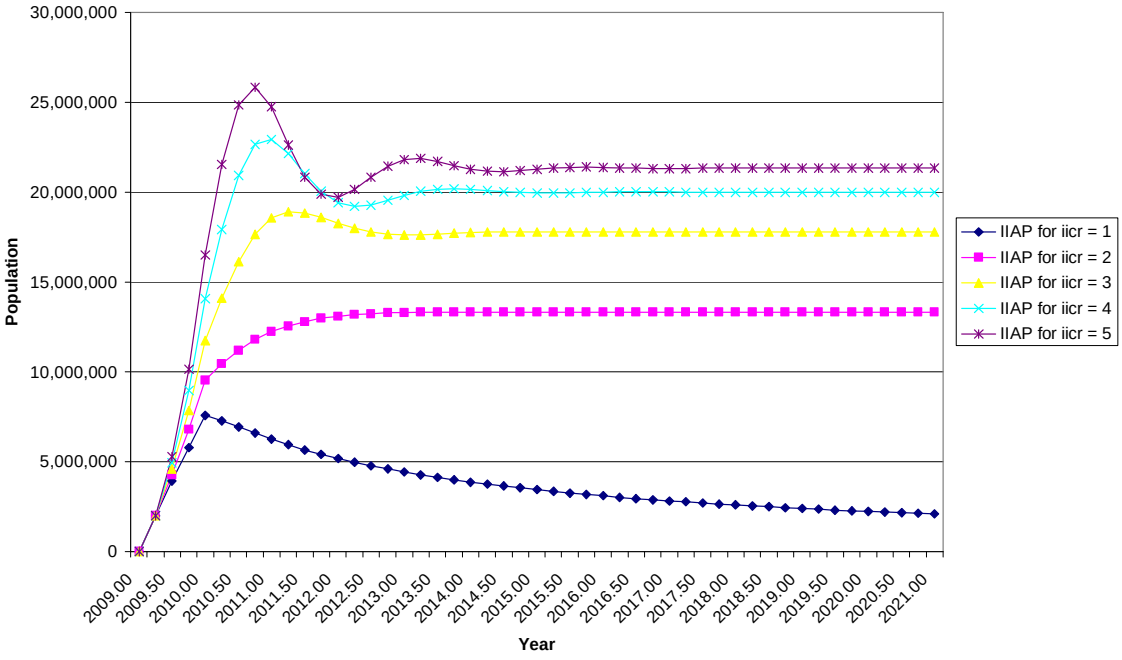

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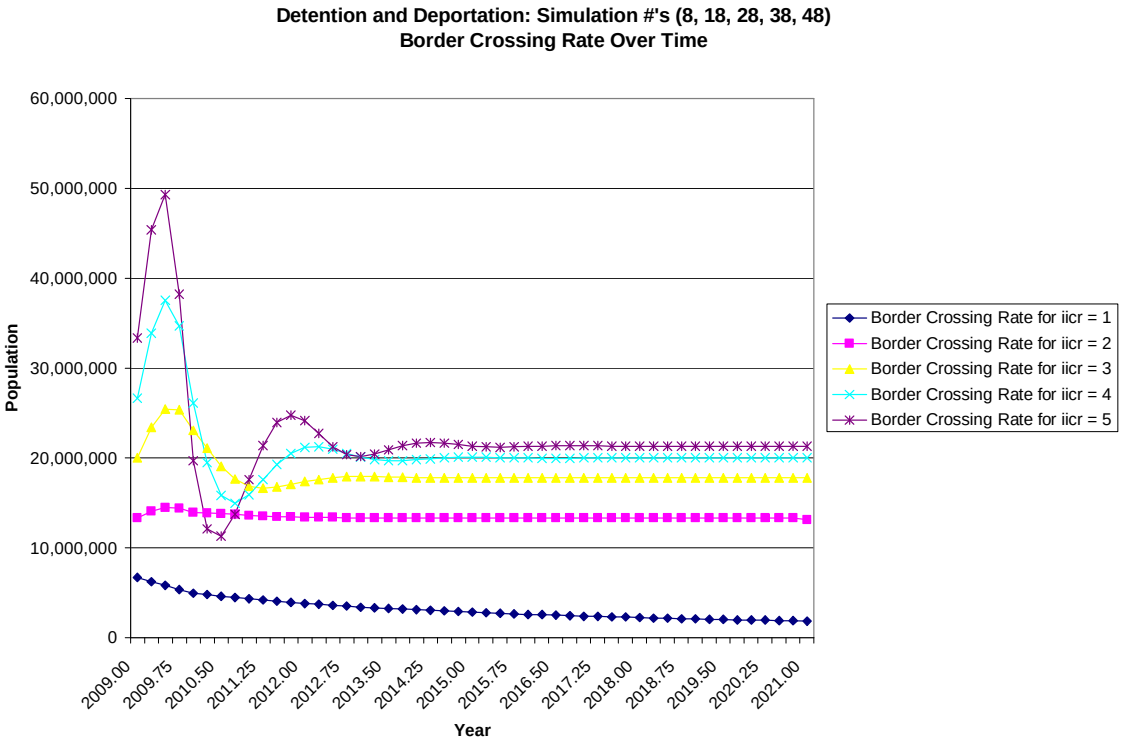

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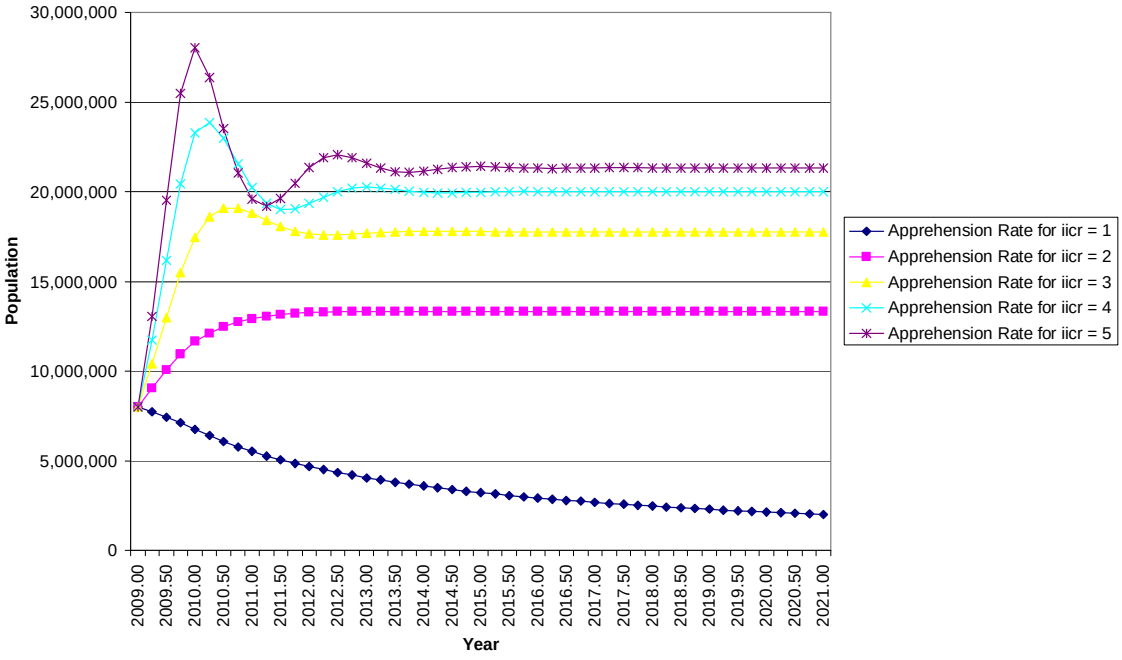

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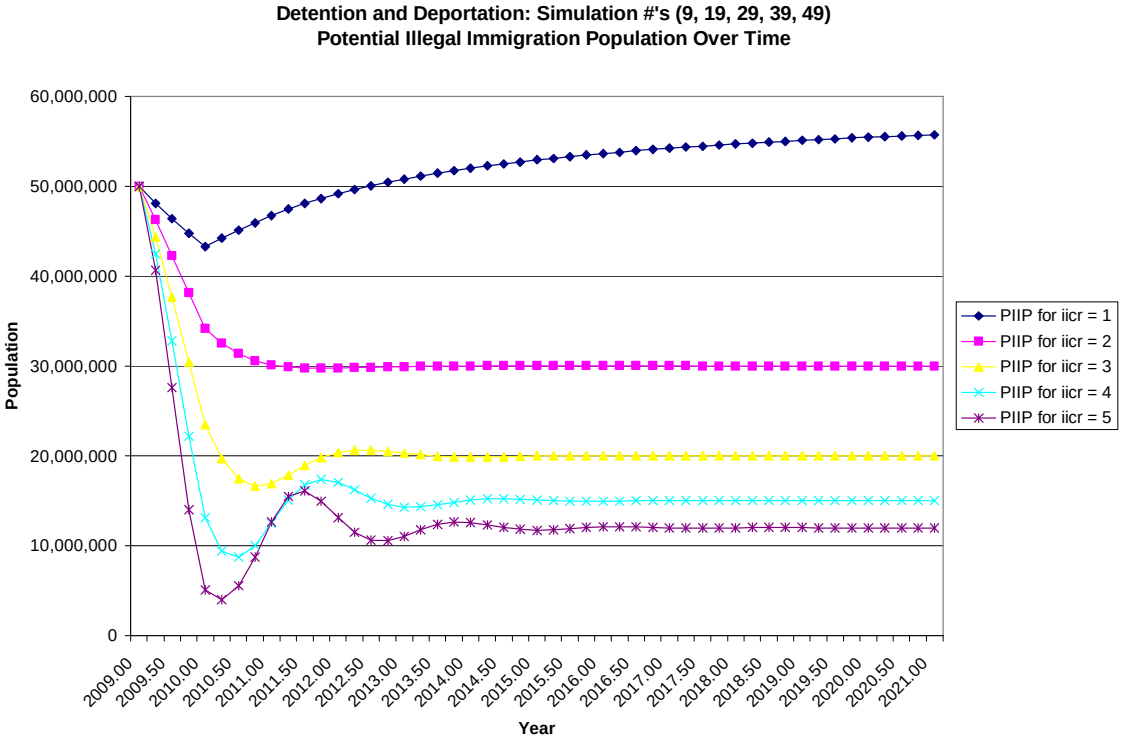

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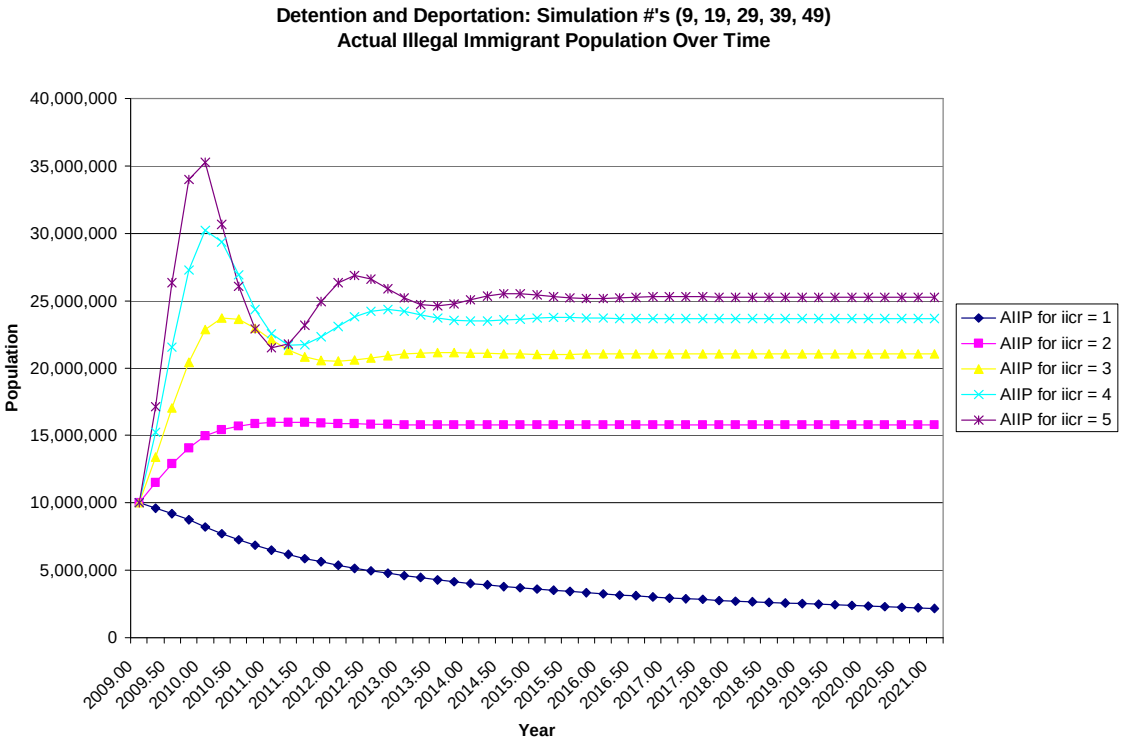

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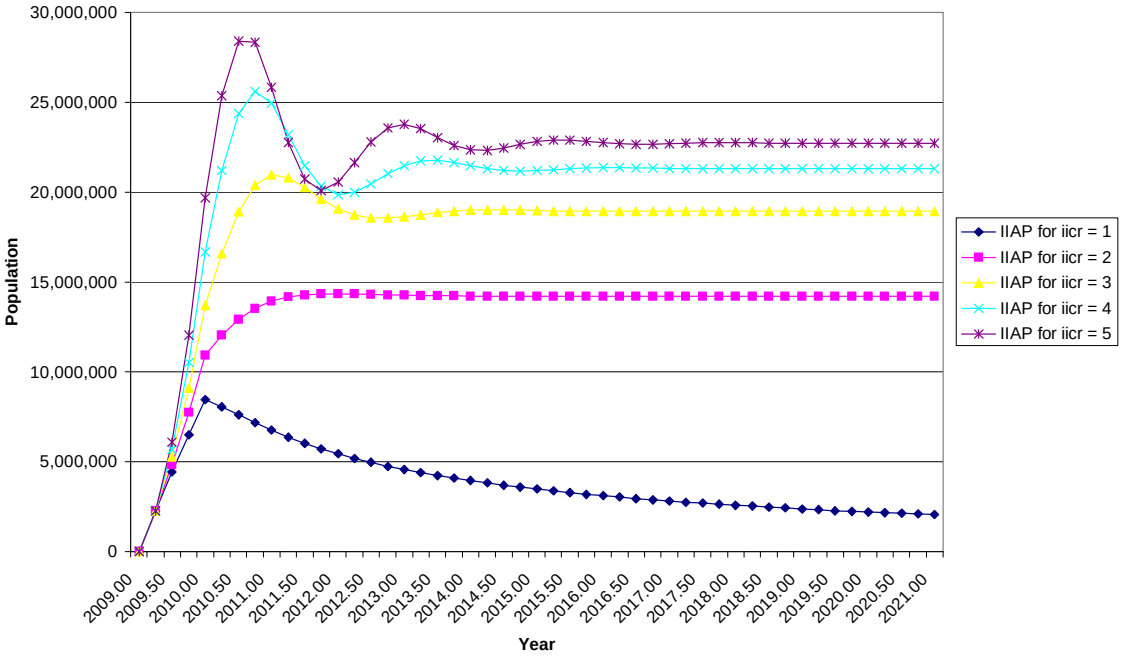

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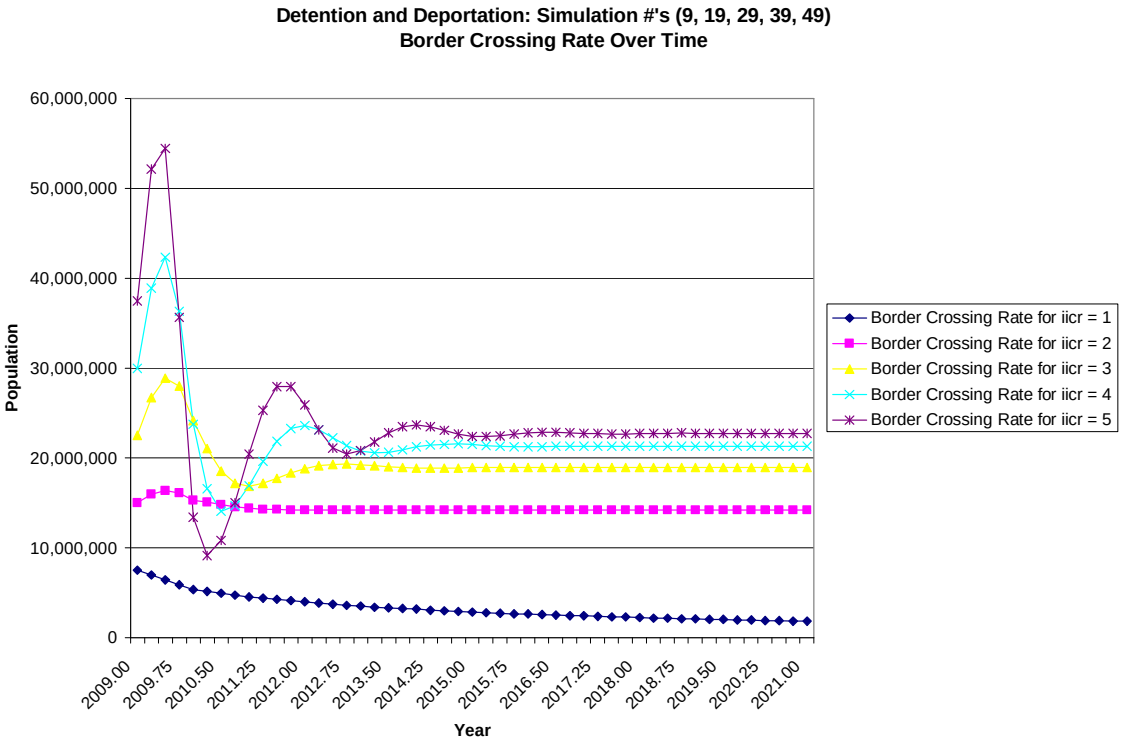

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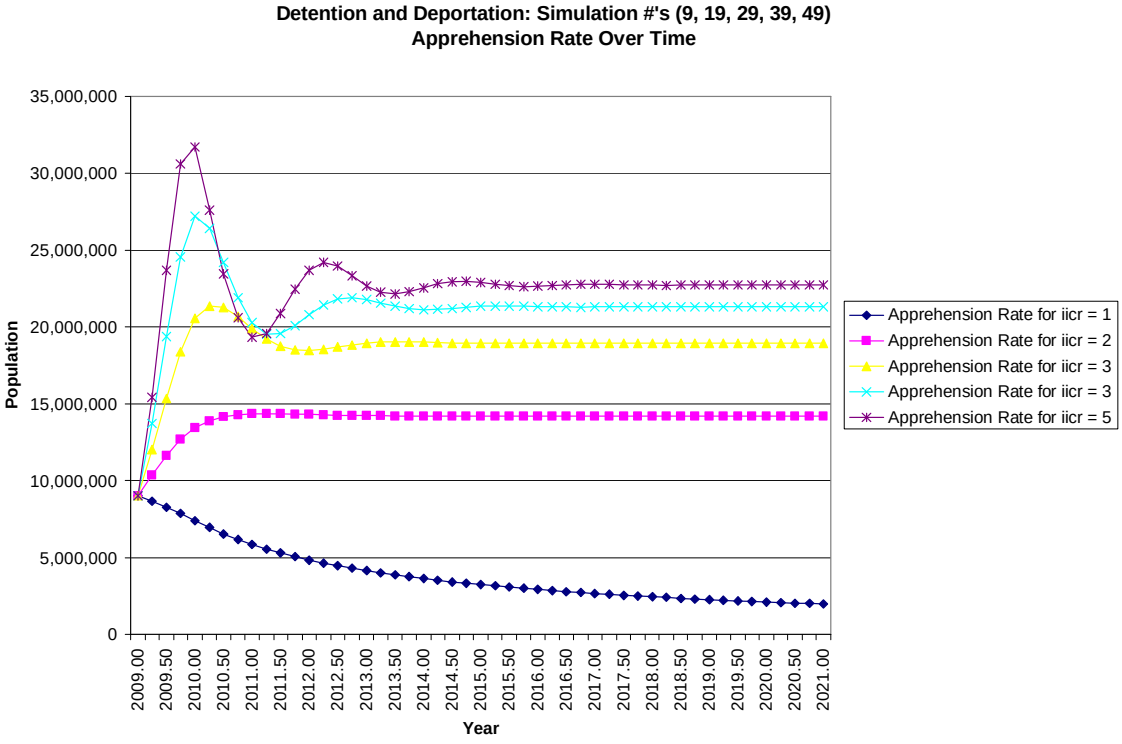

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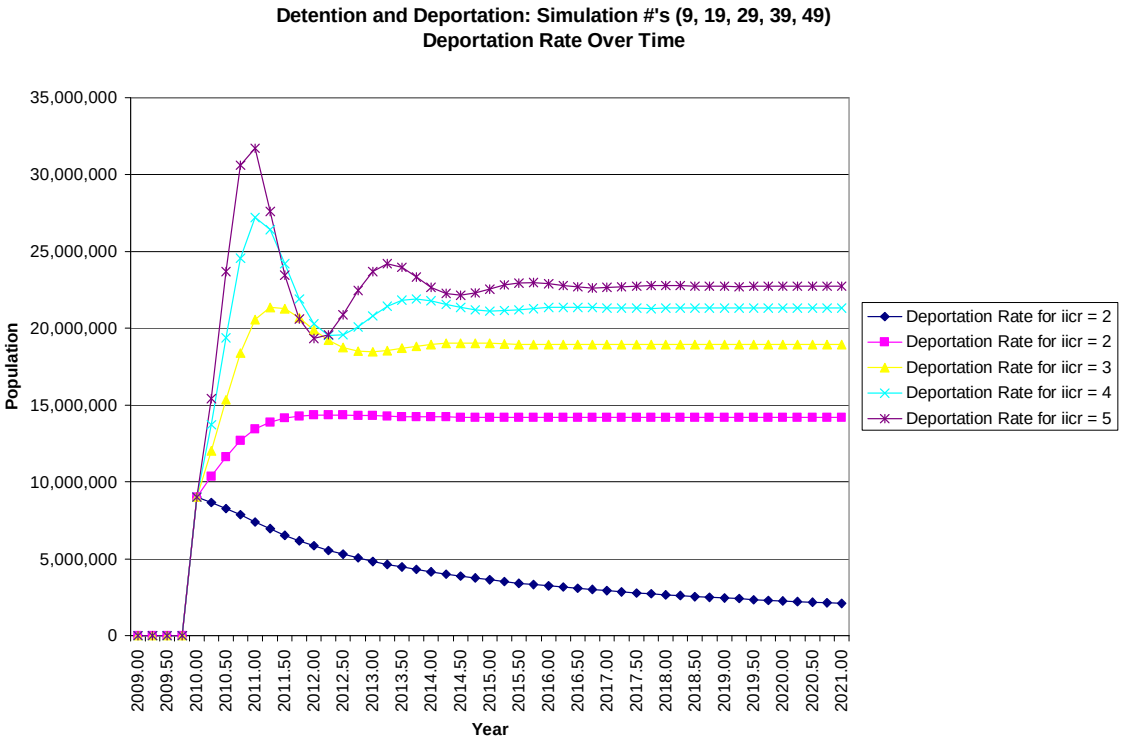

IX.3 C

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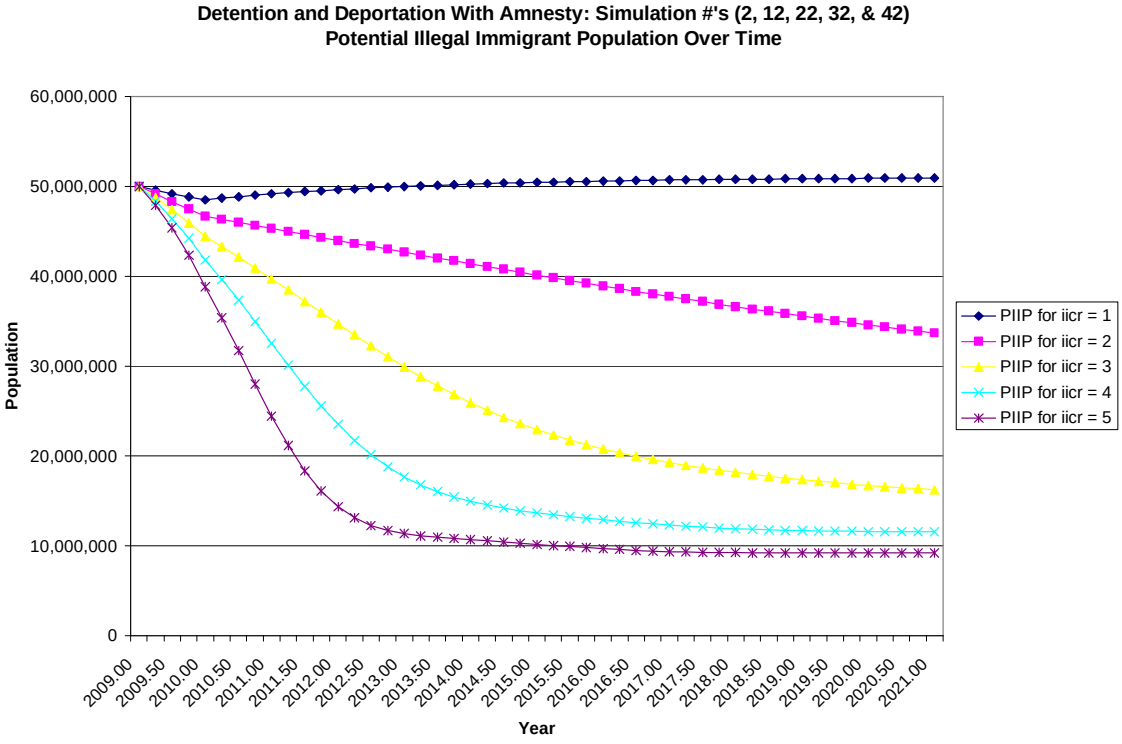

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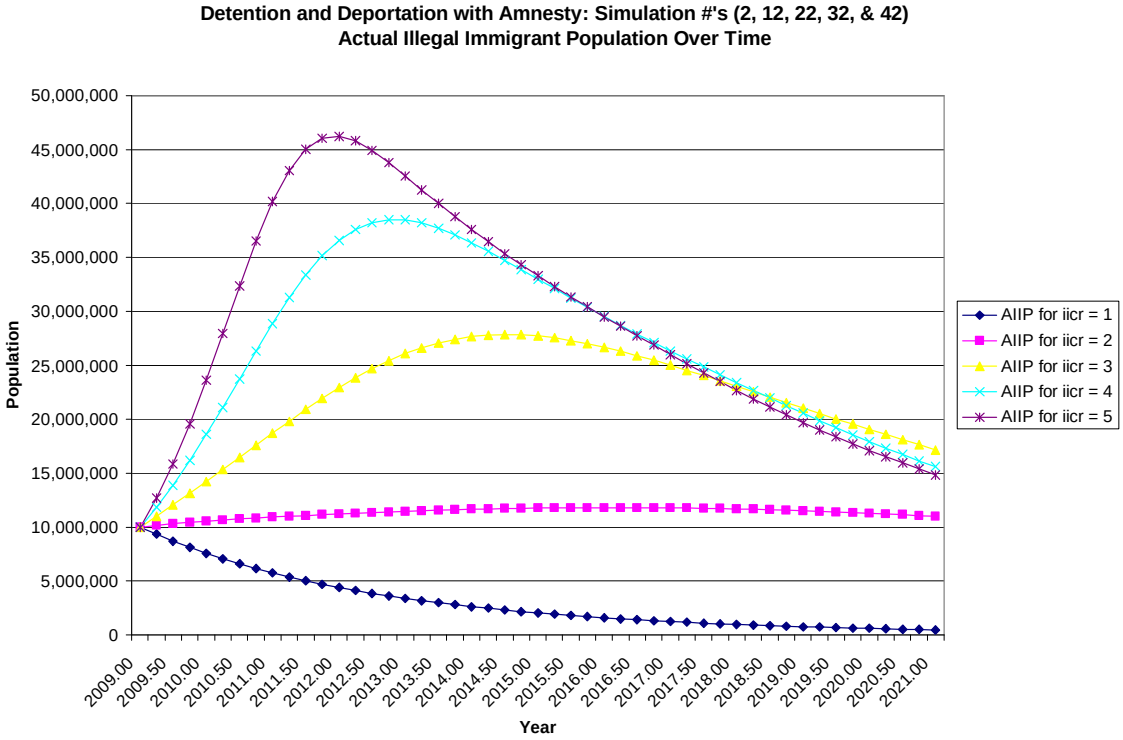

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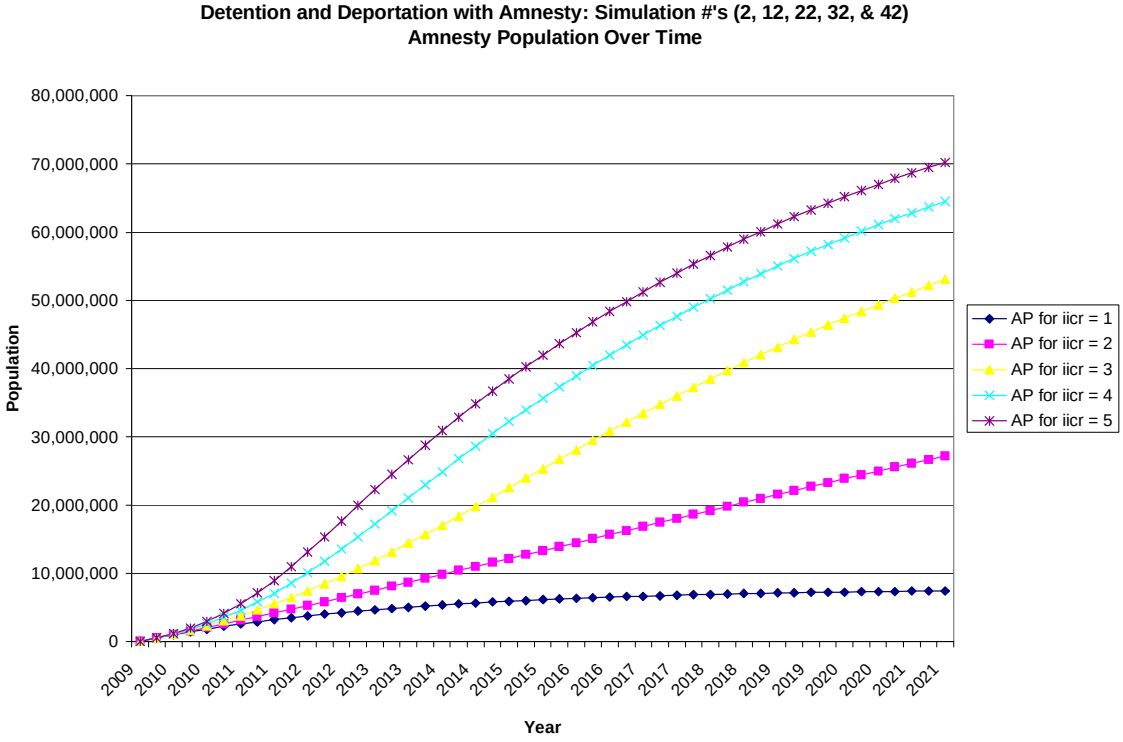

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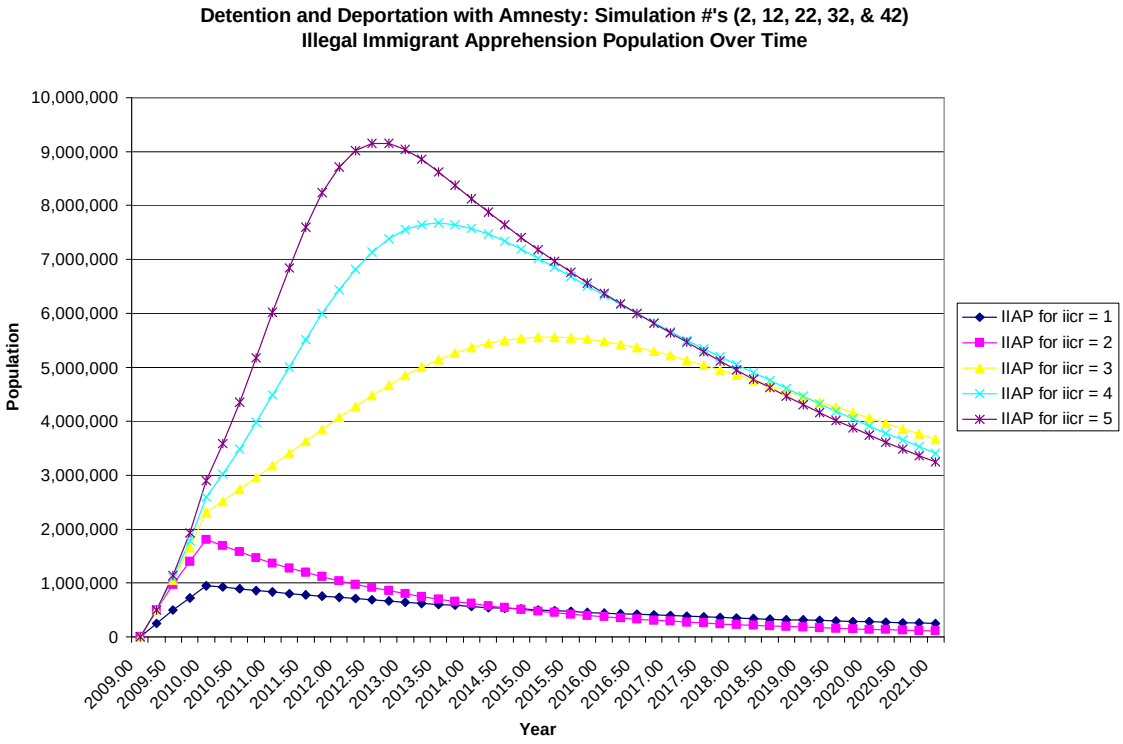

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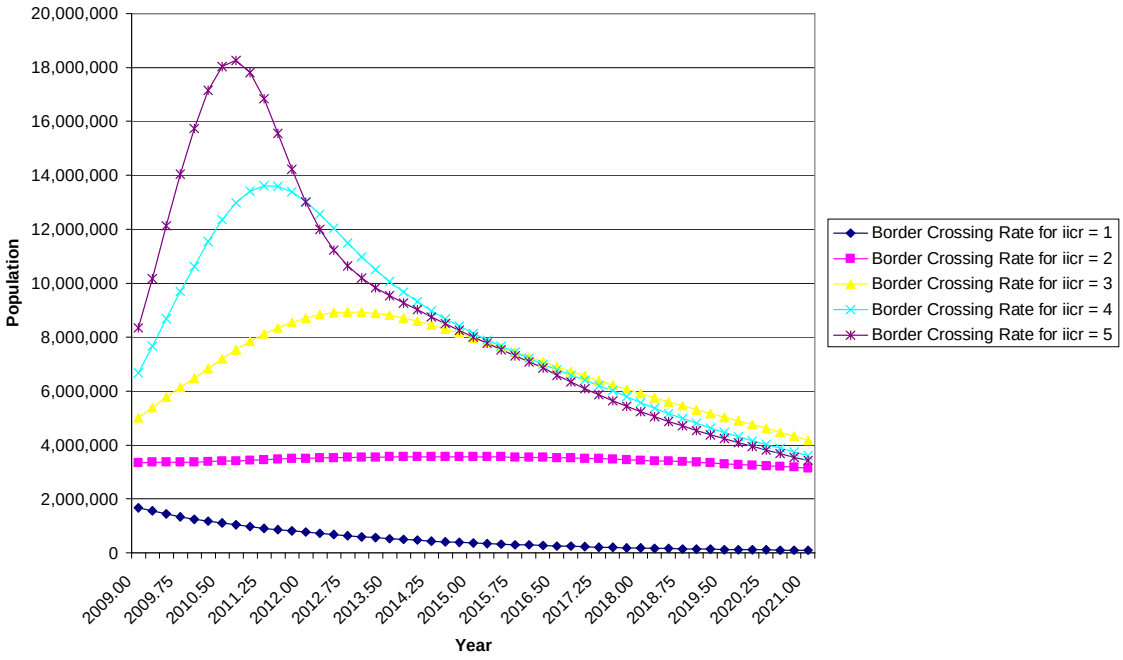

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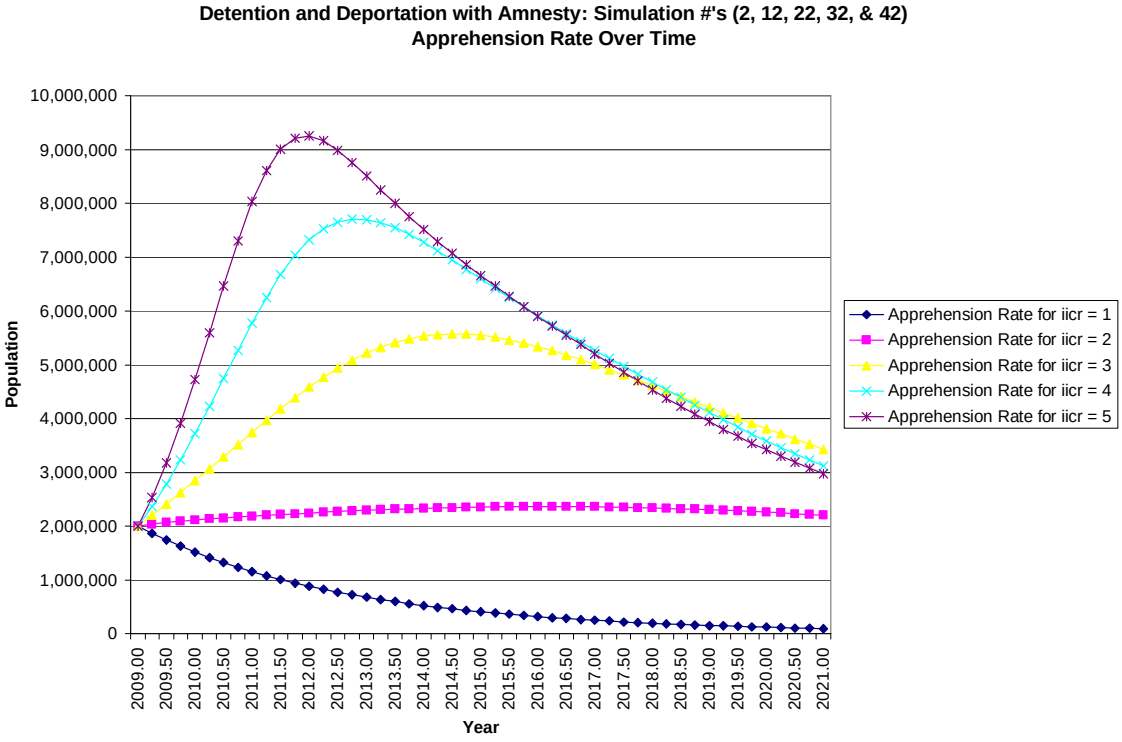

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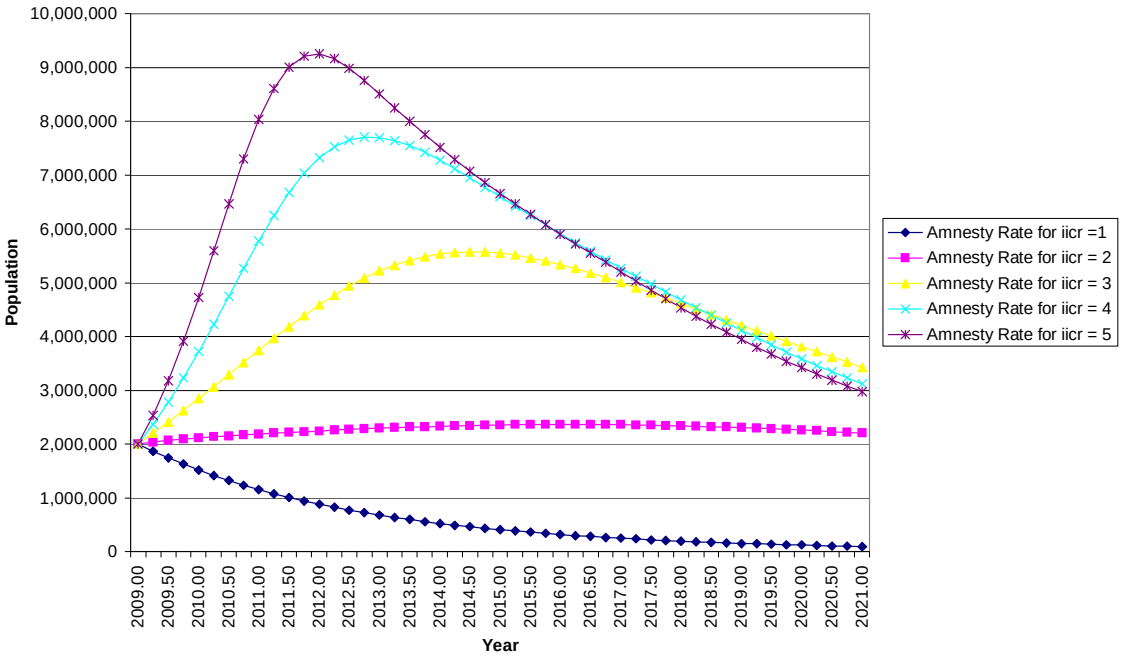

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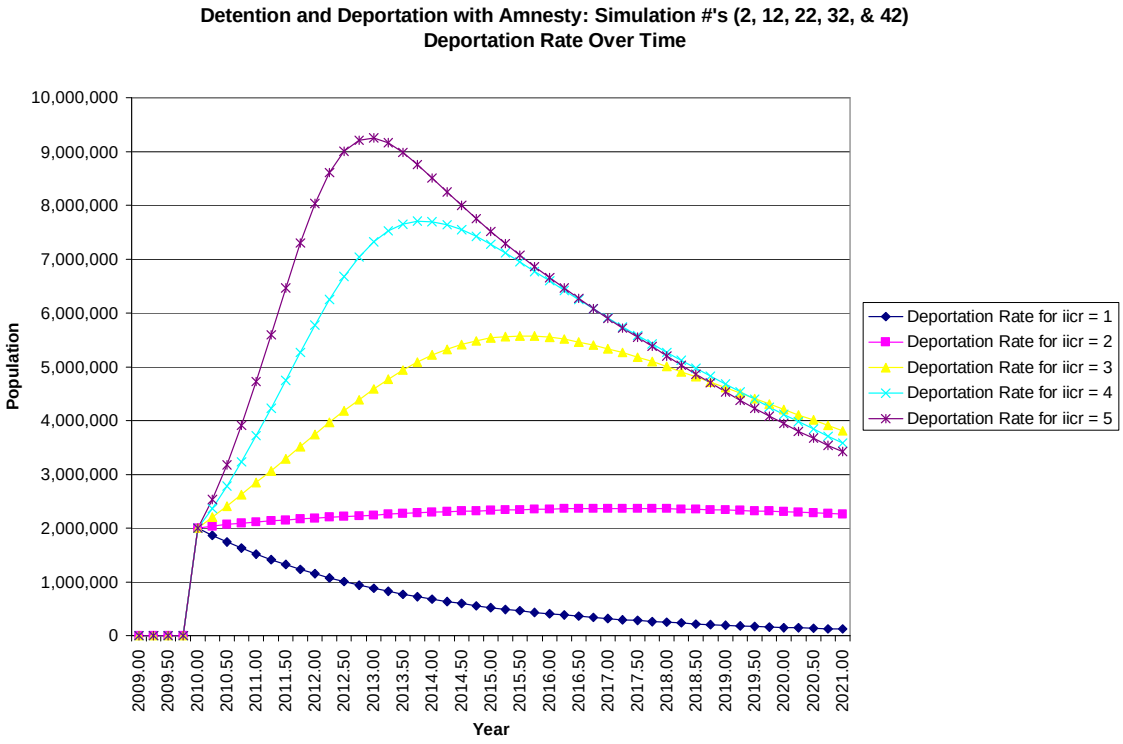

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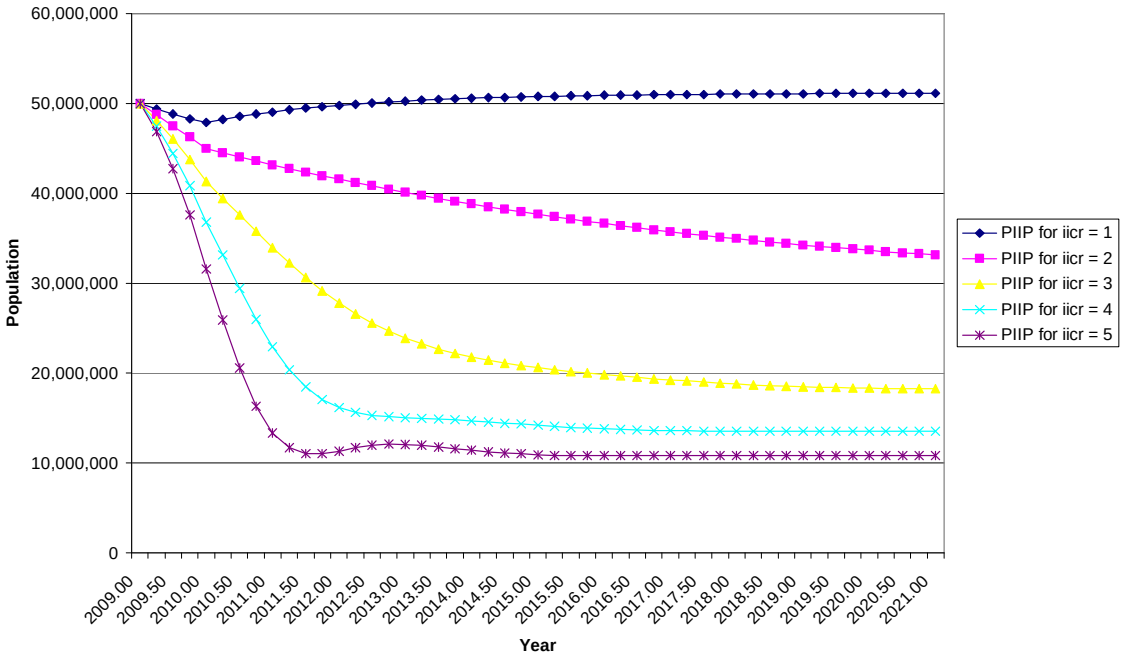

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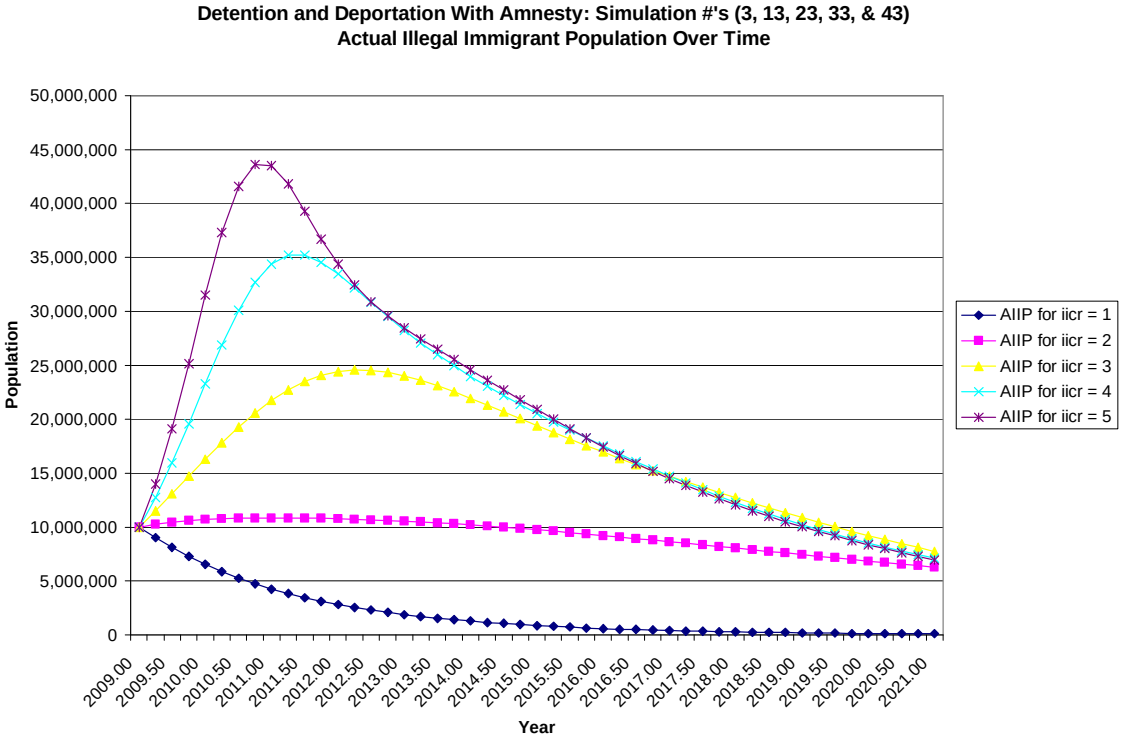

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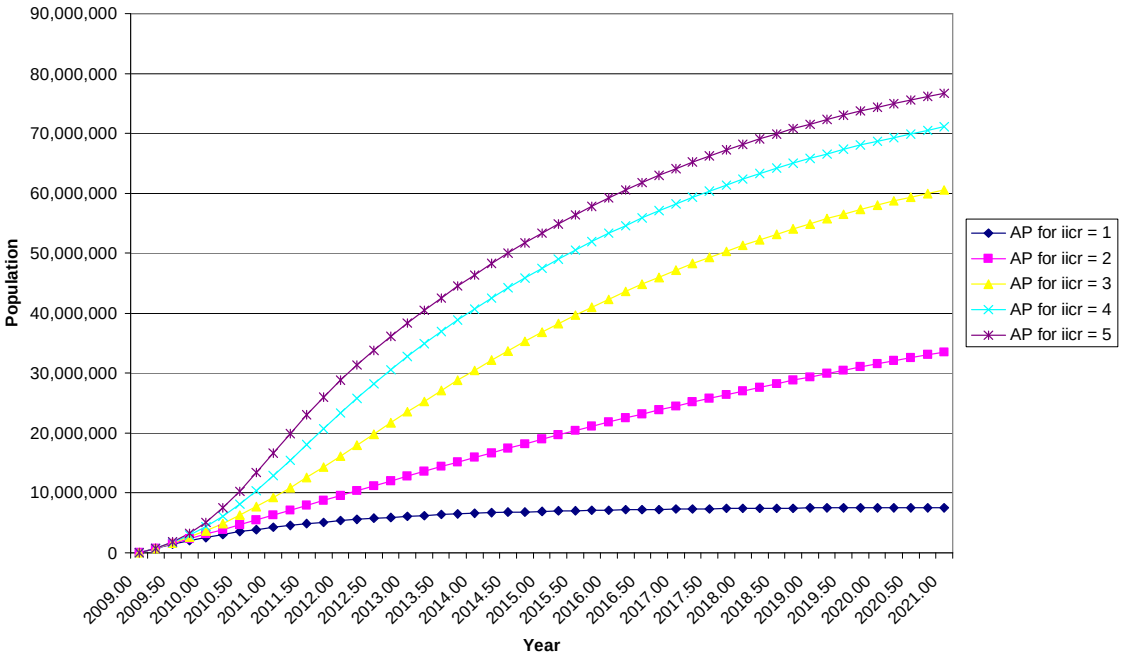

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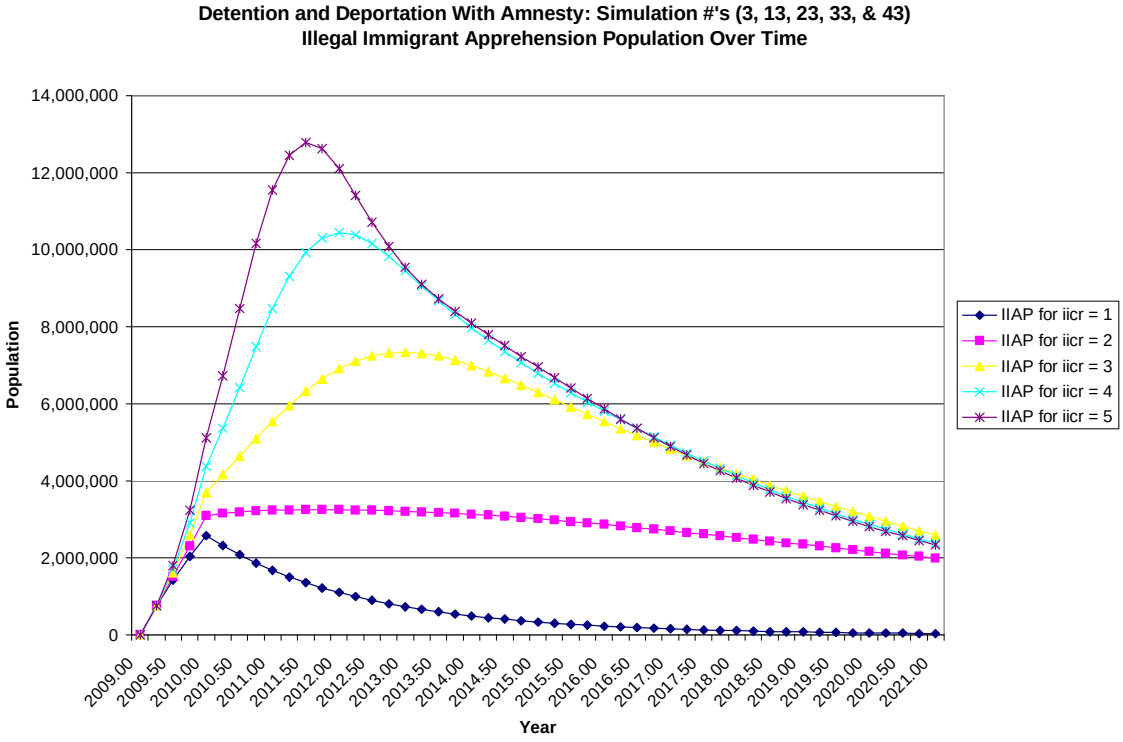

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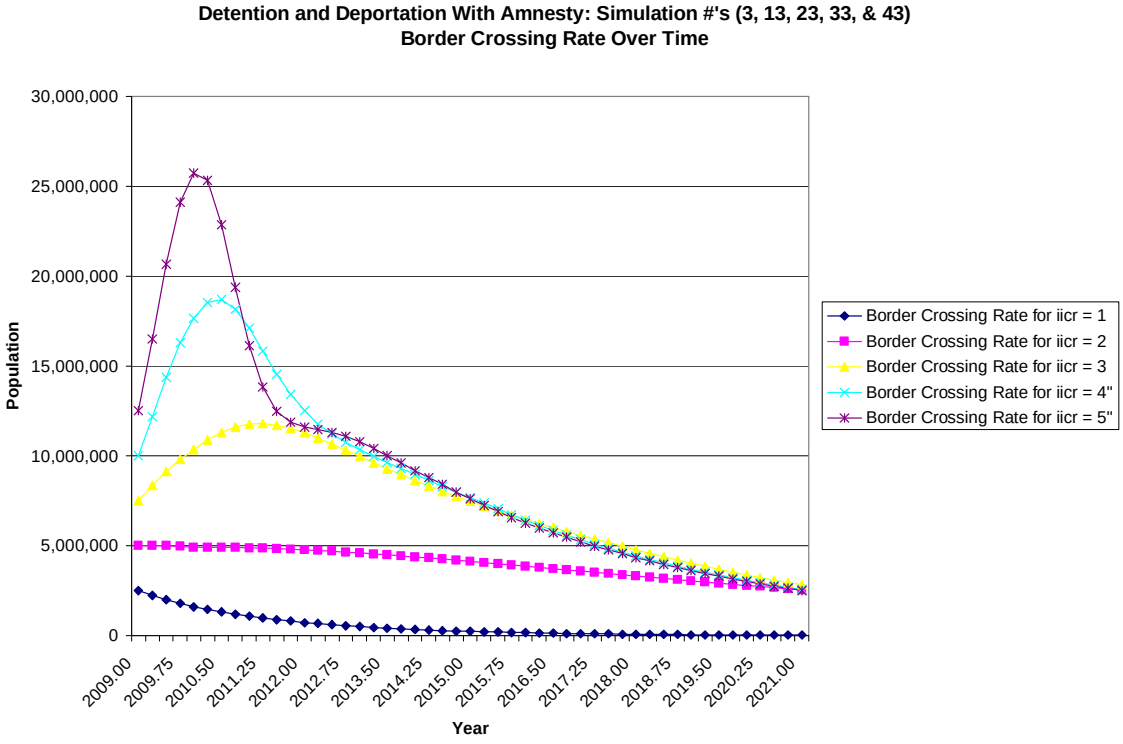

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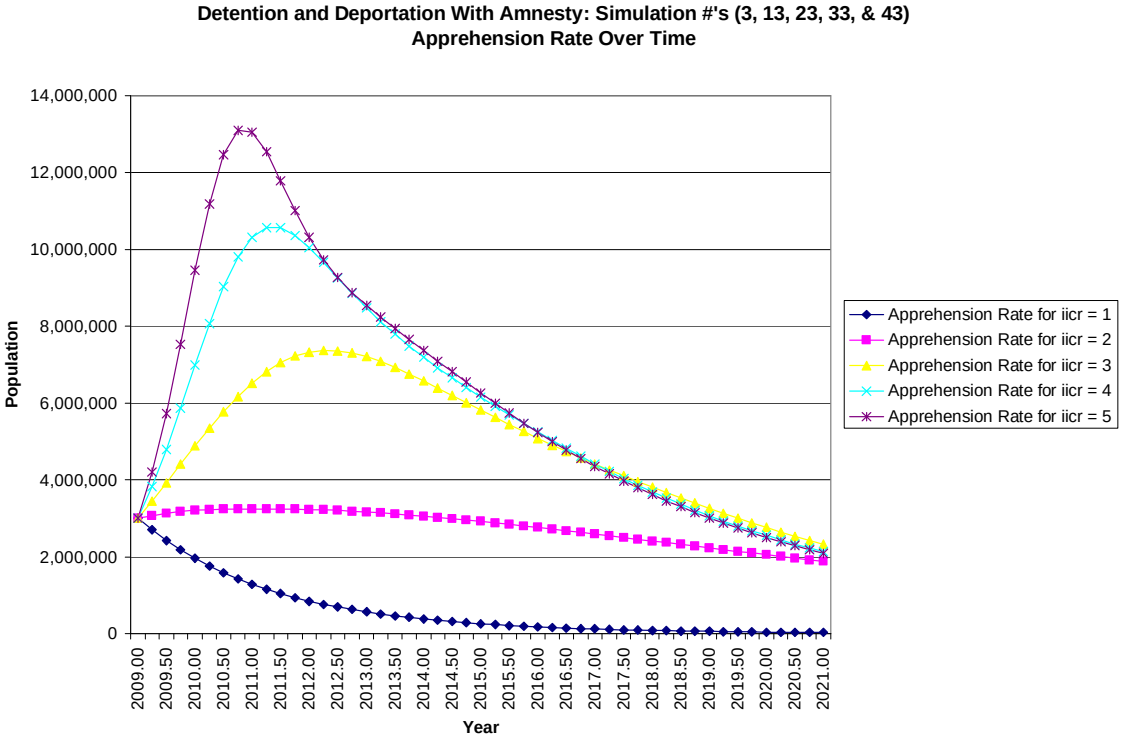

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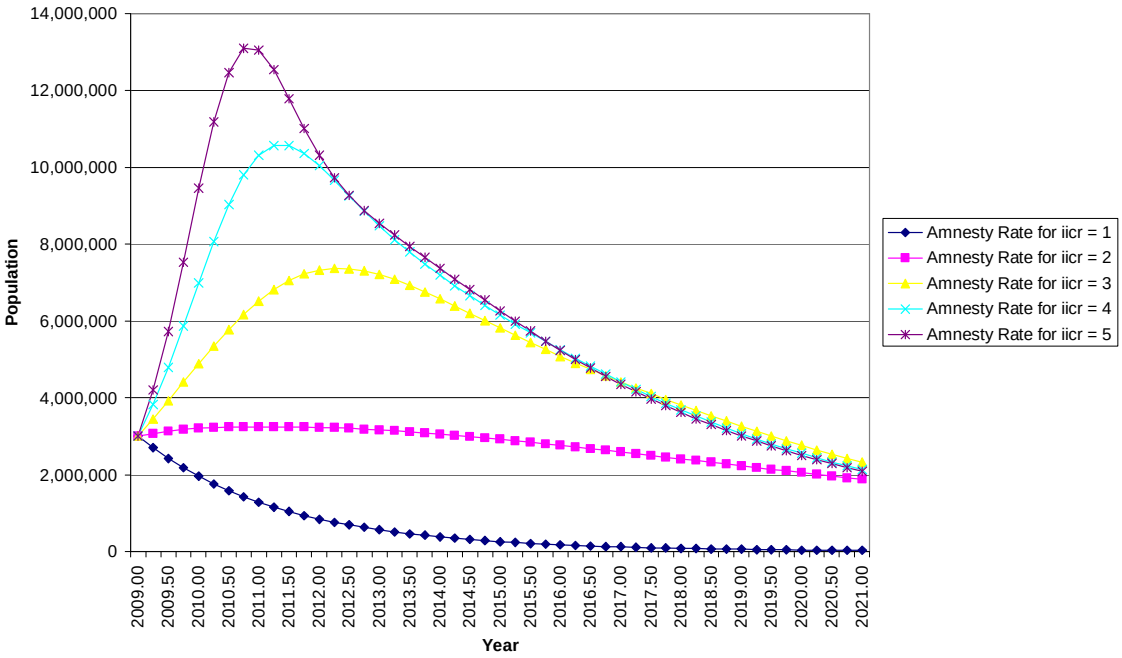

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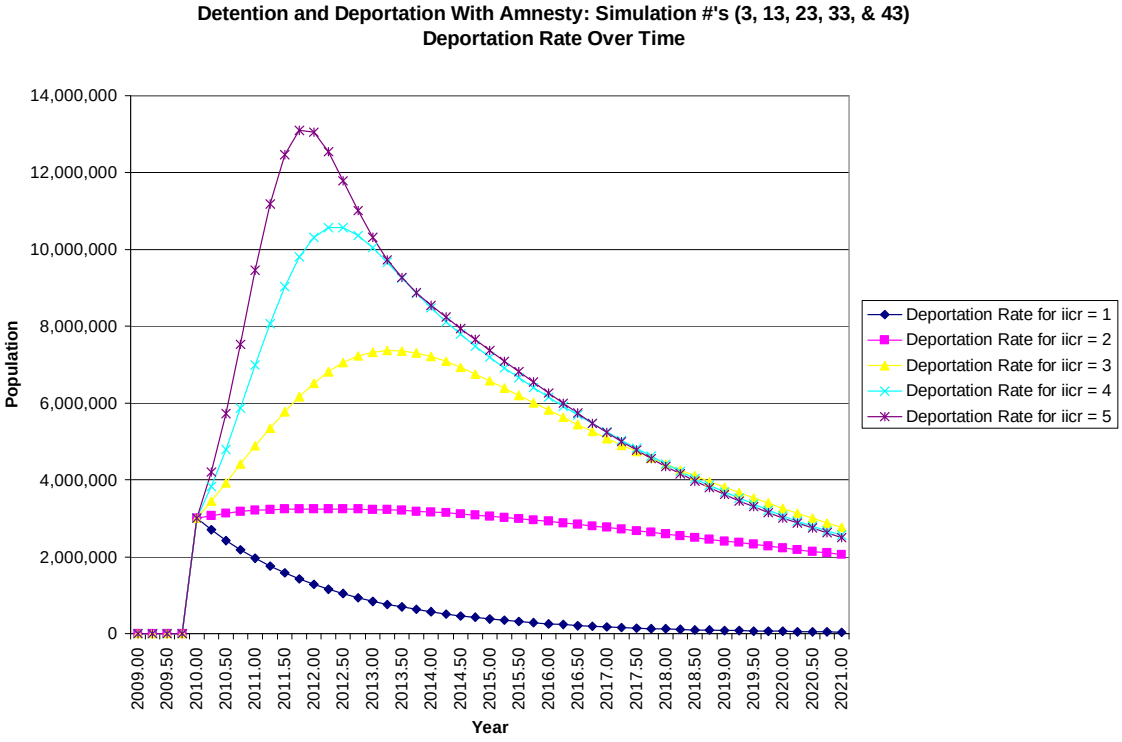

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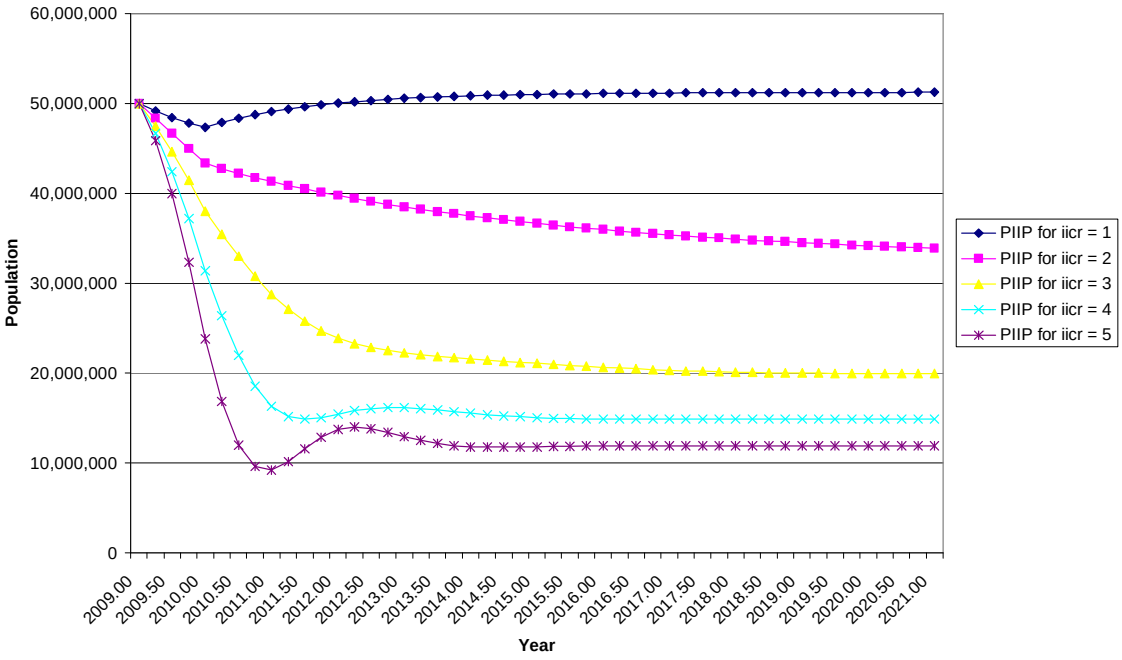

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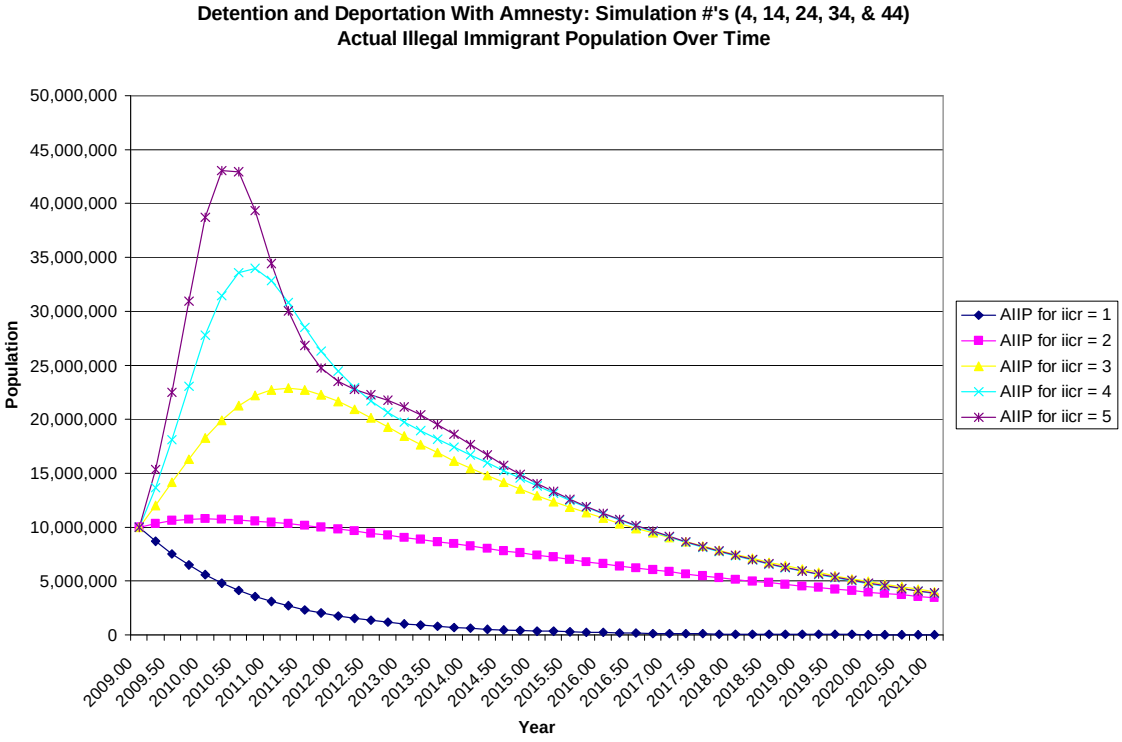

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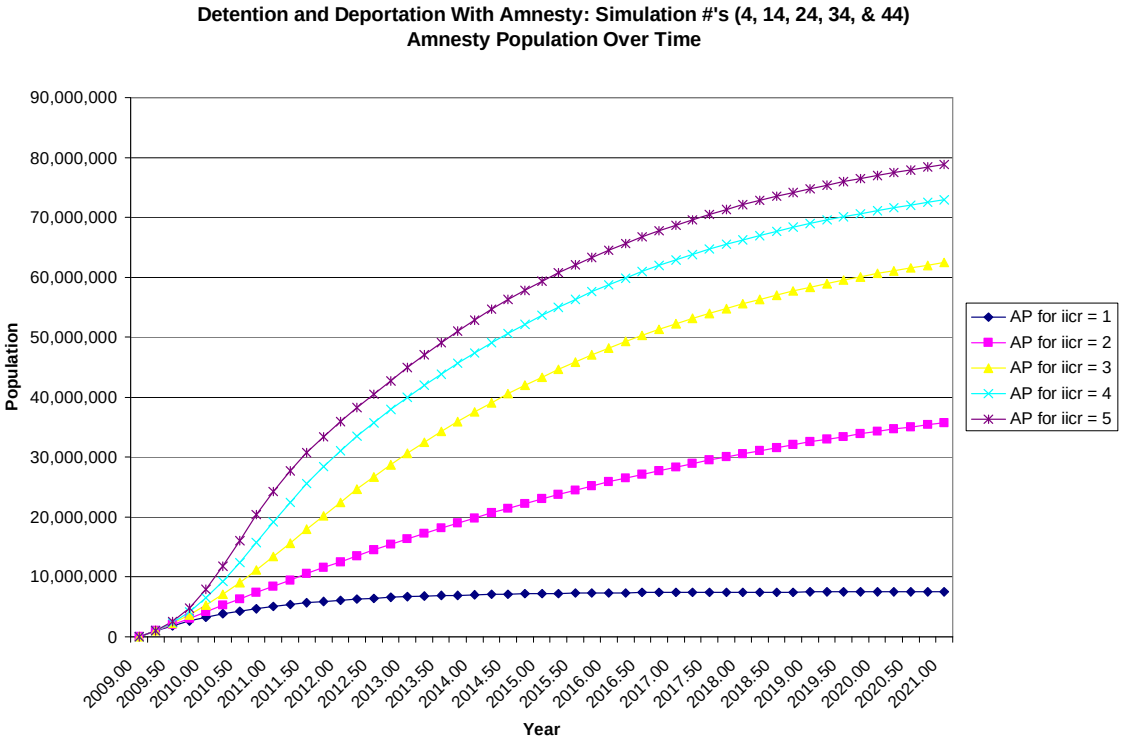

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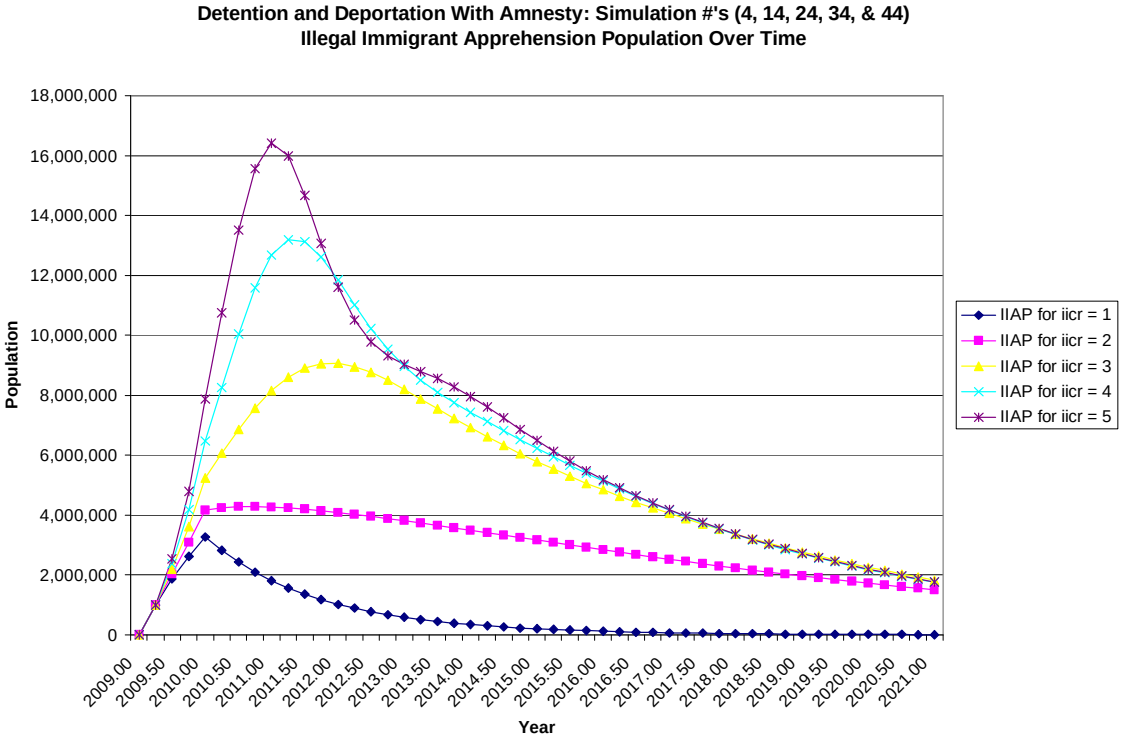

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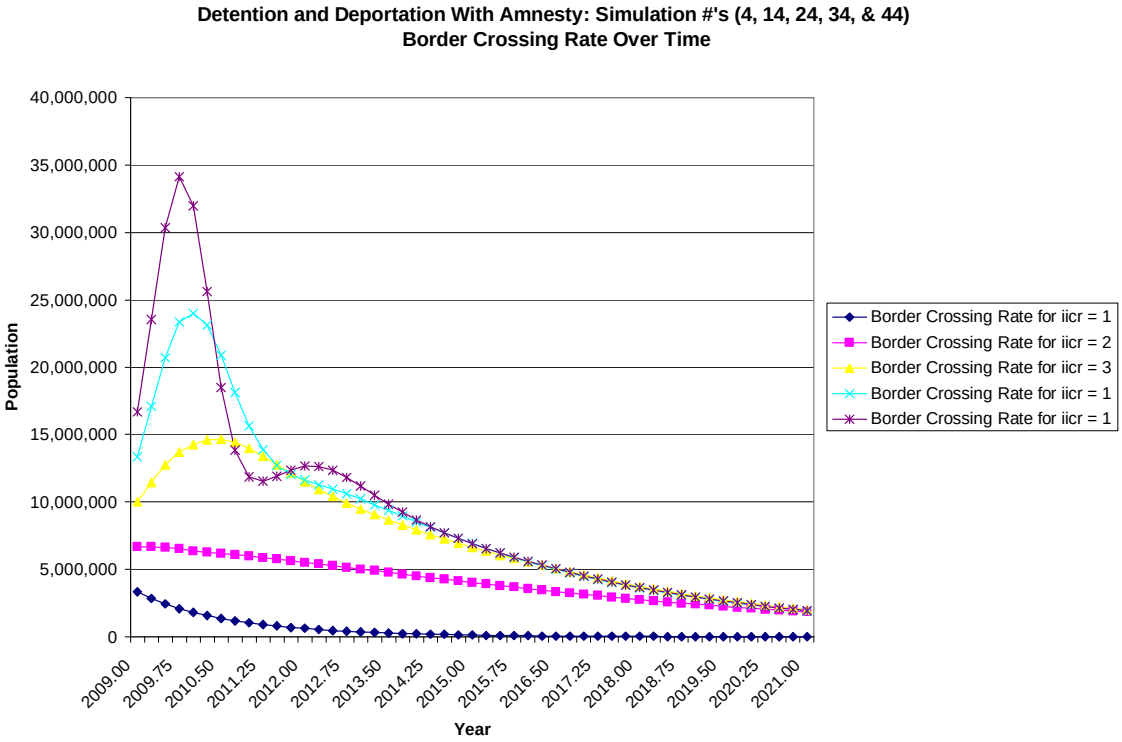
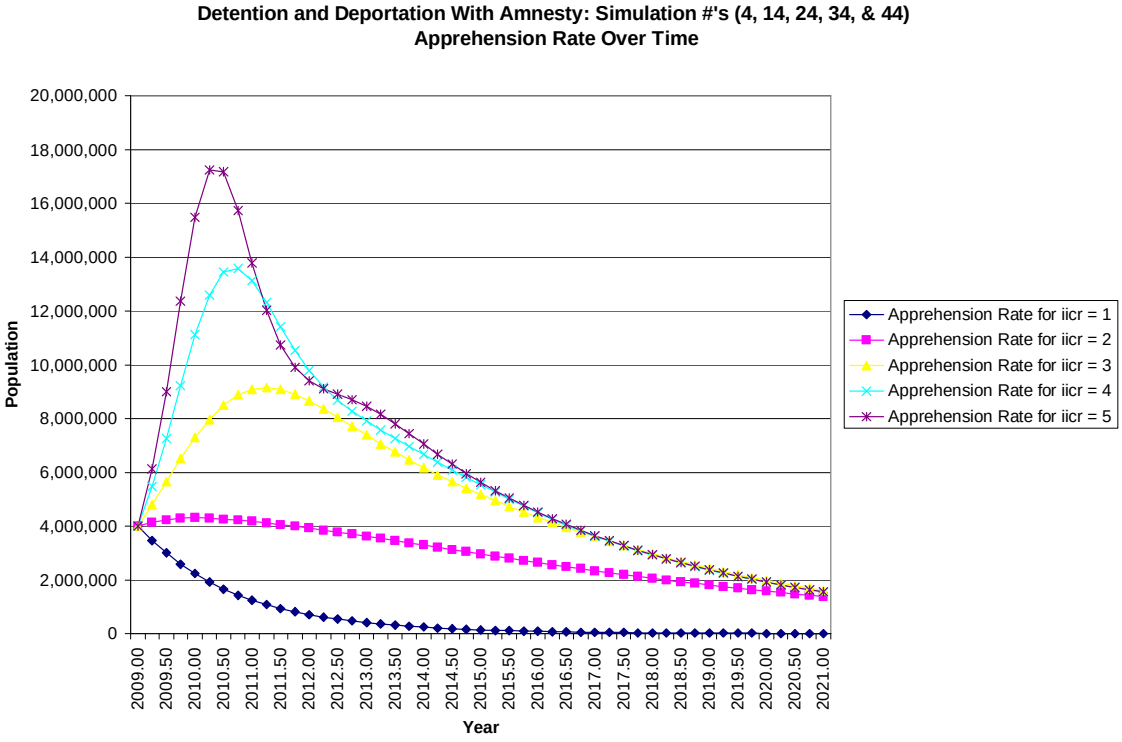


Chart 22



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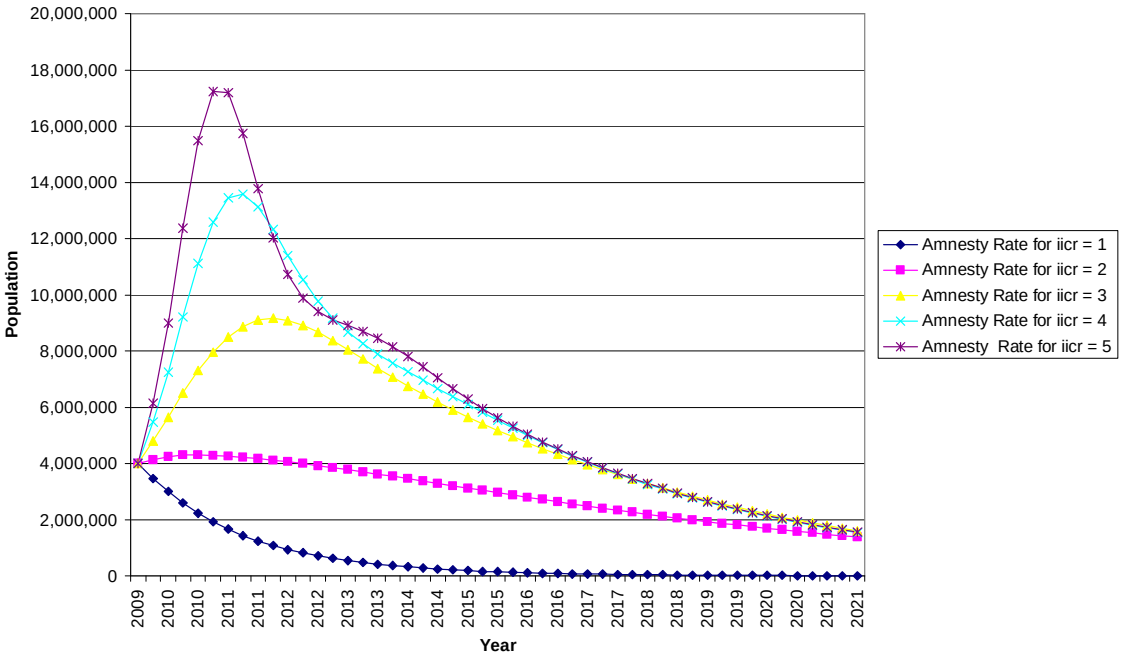

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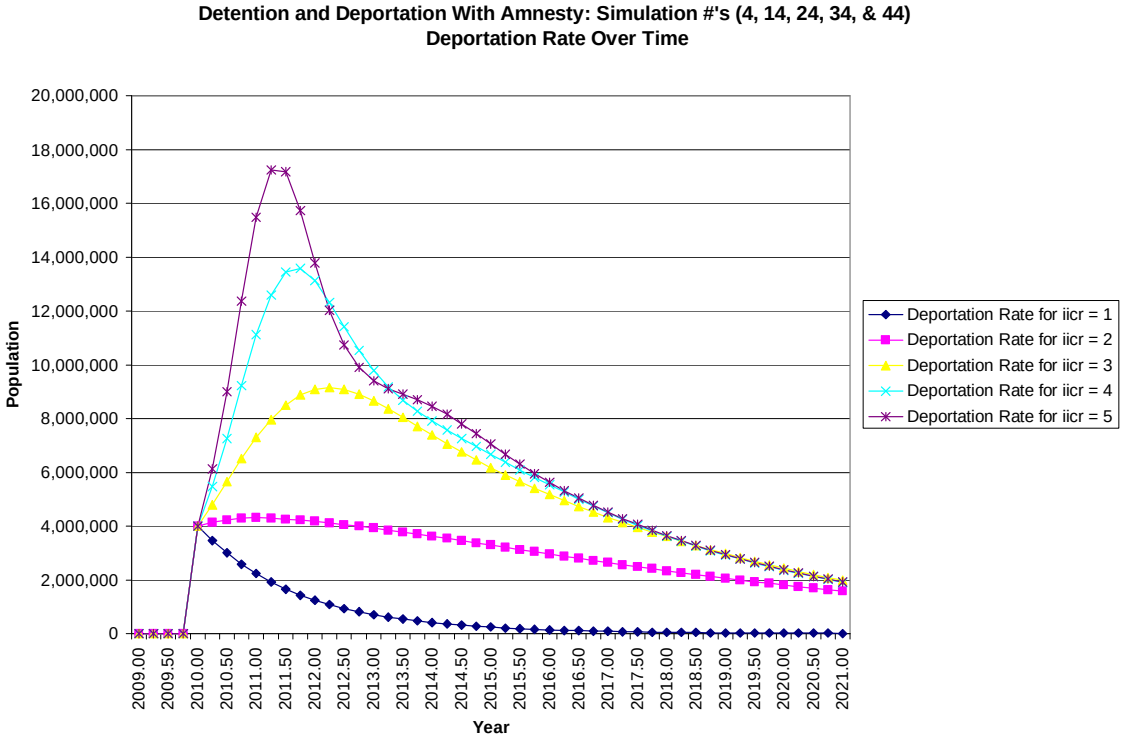

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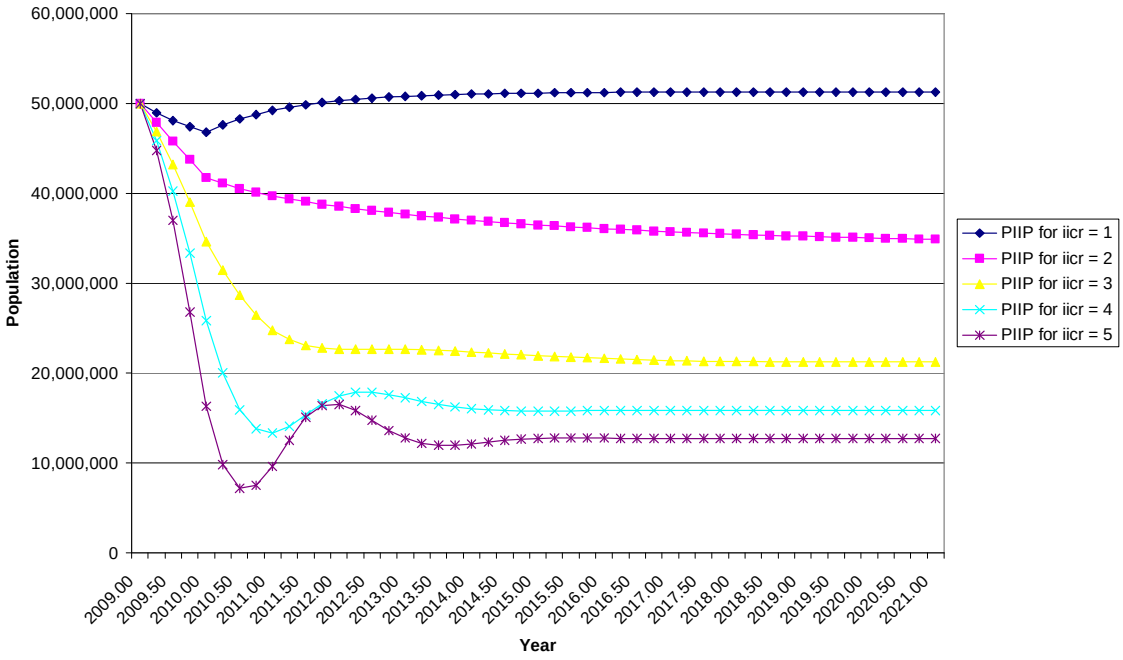

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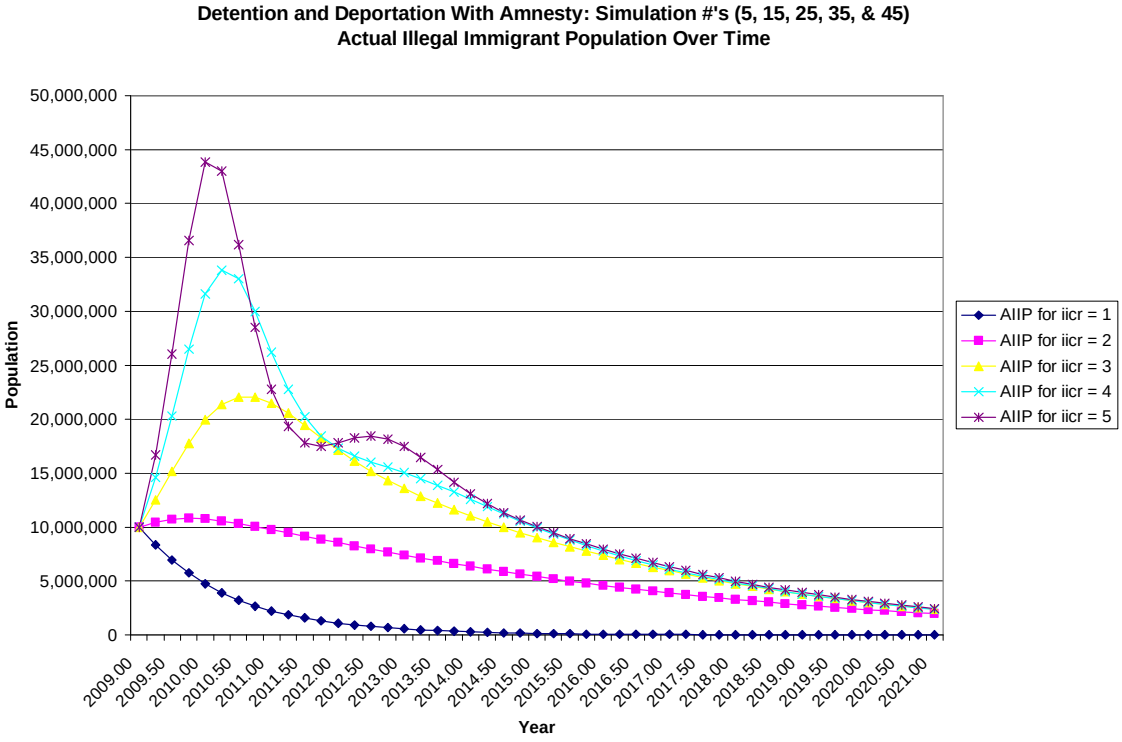

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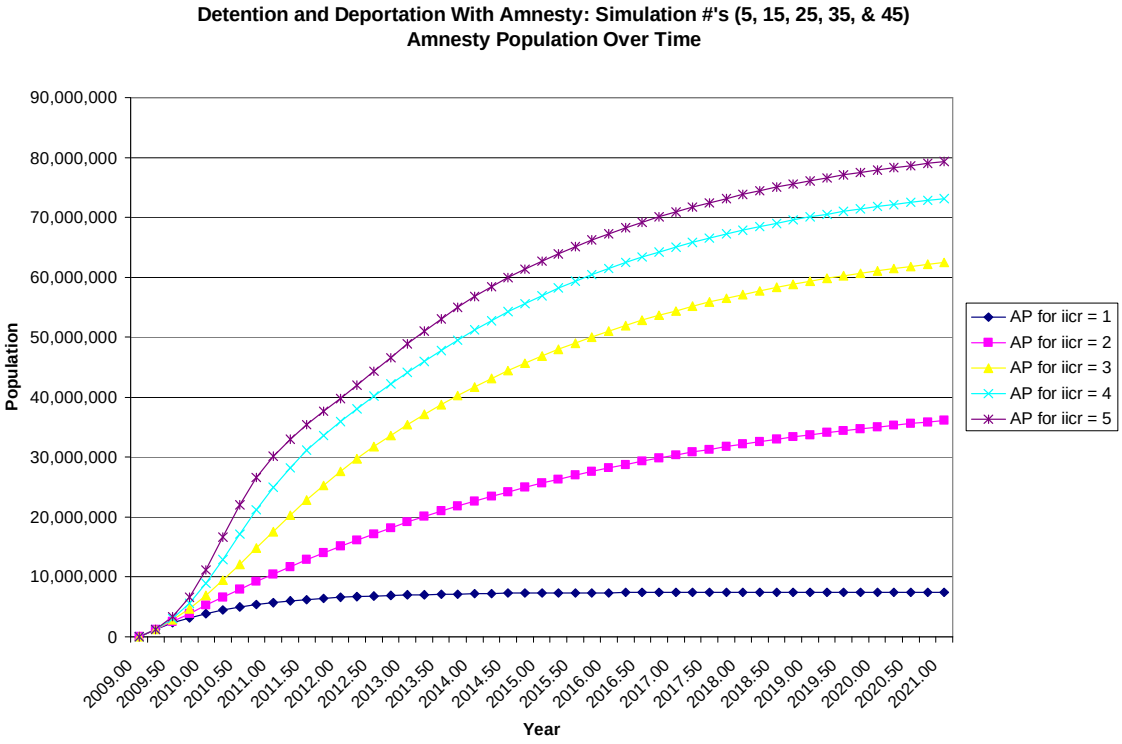

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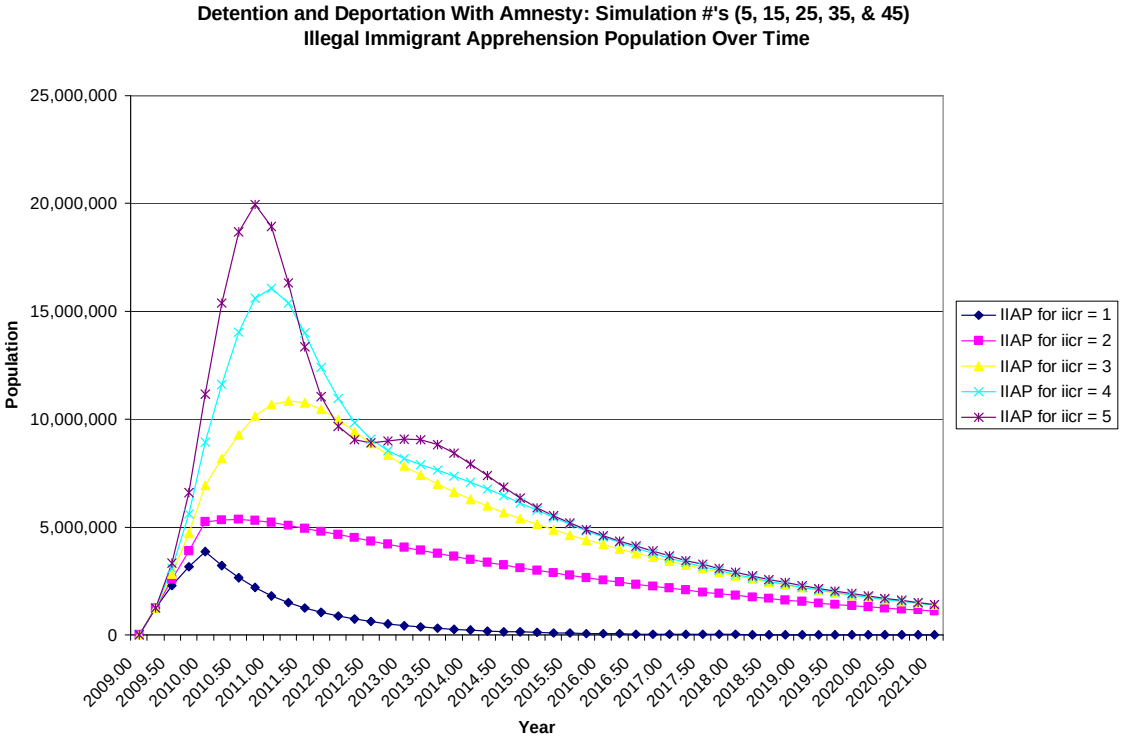

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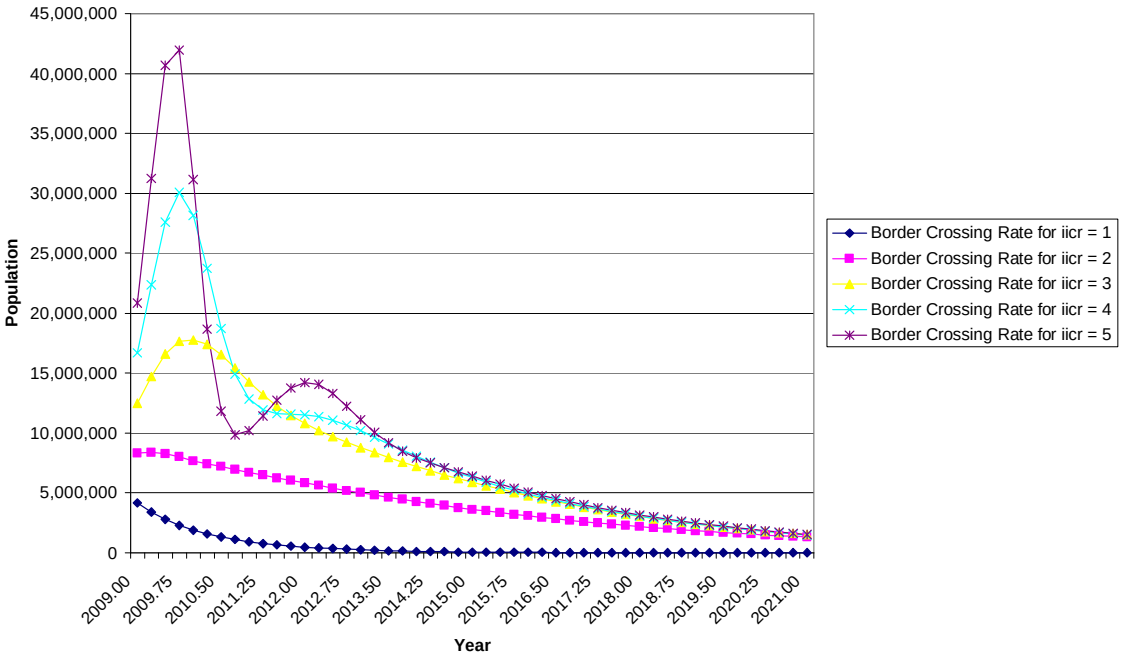

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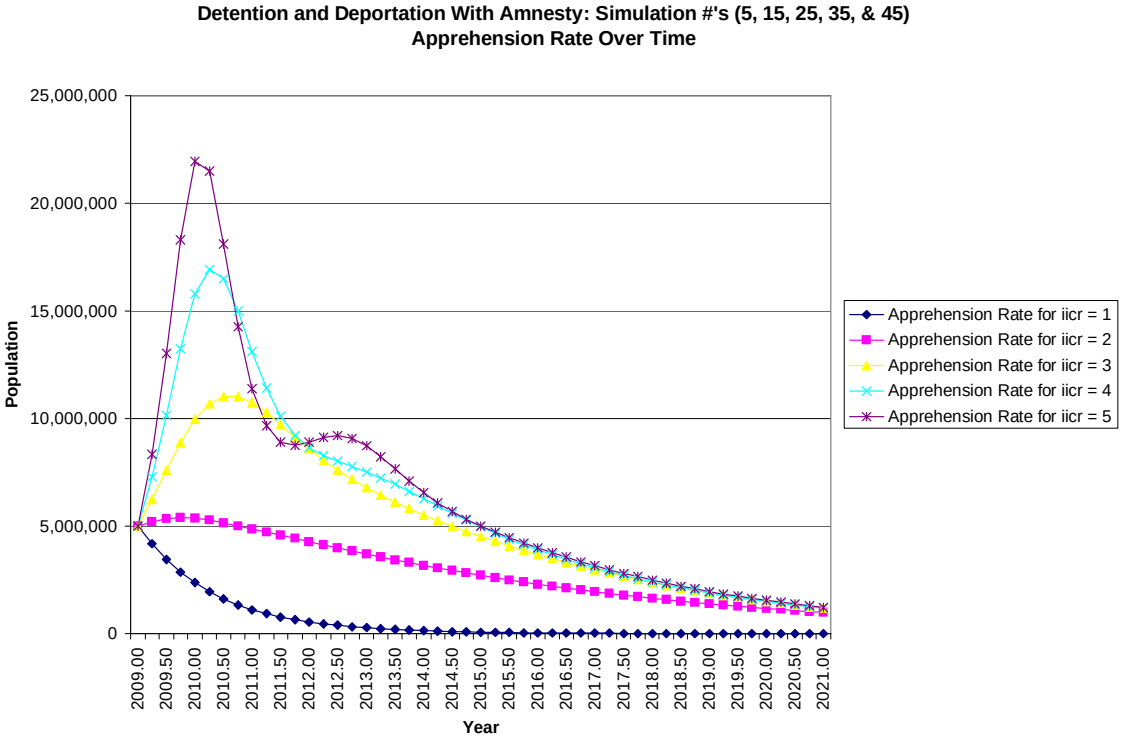

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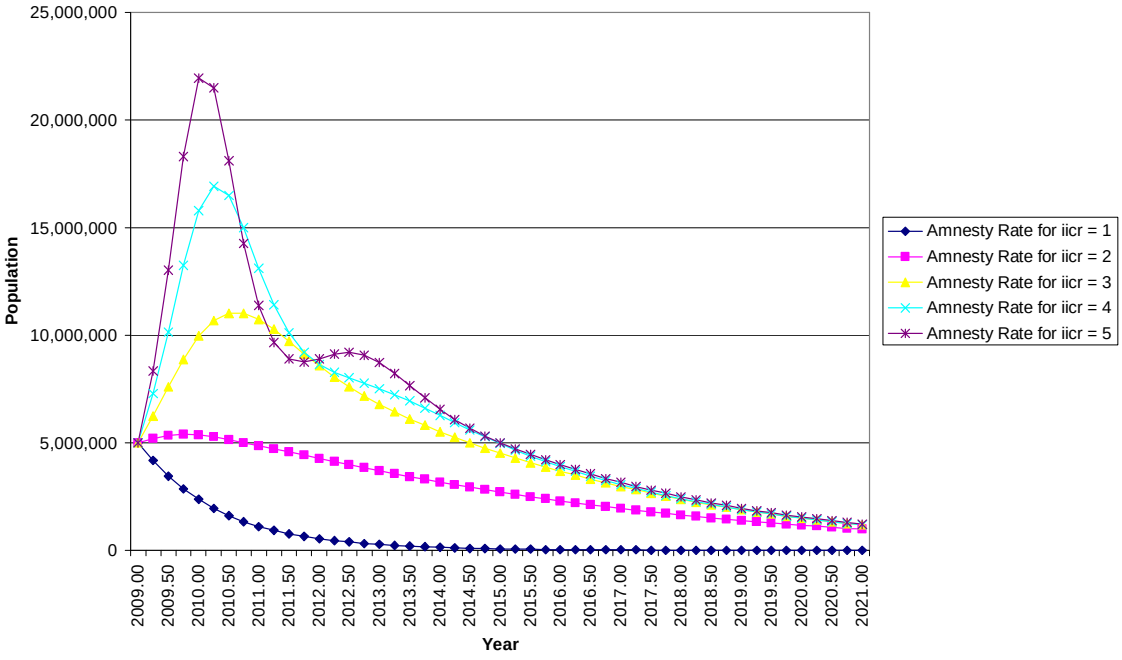

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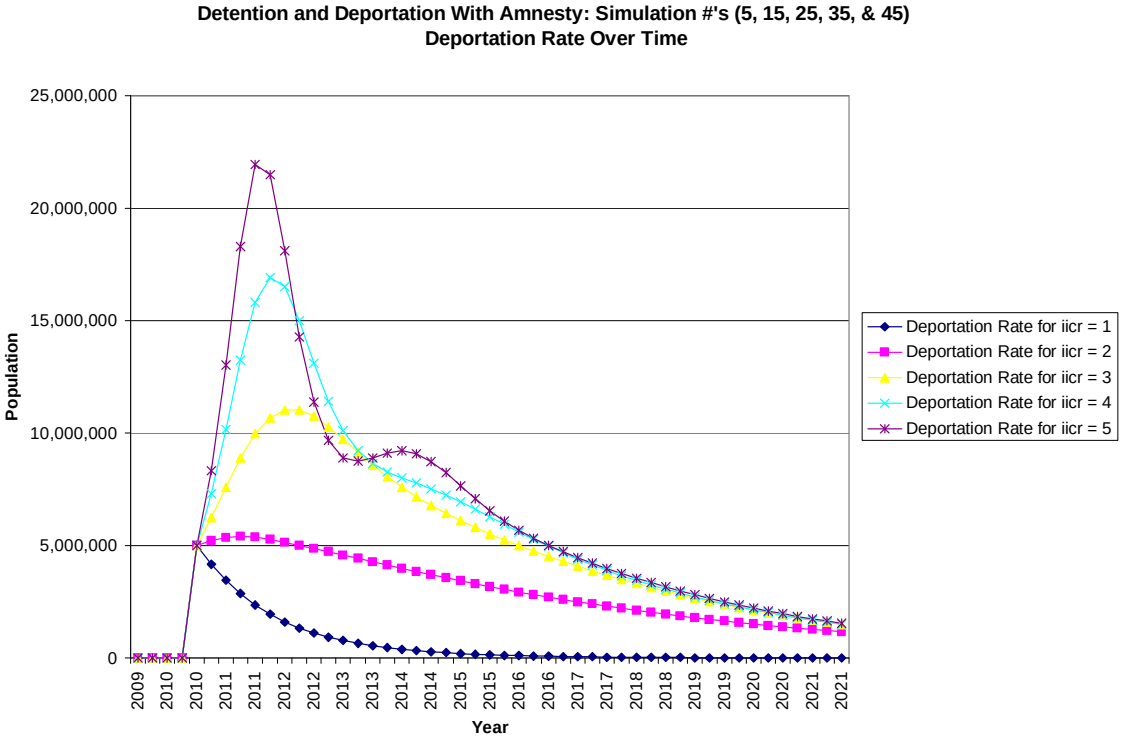

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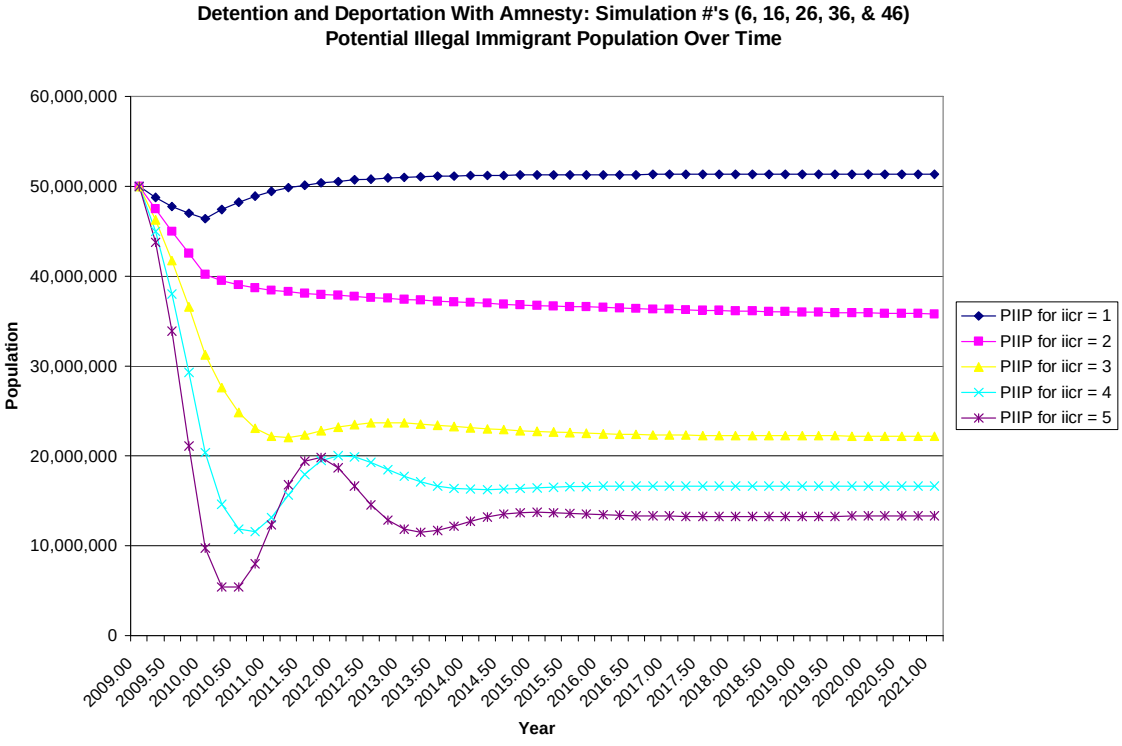

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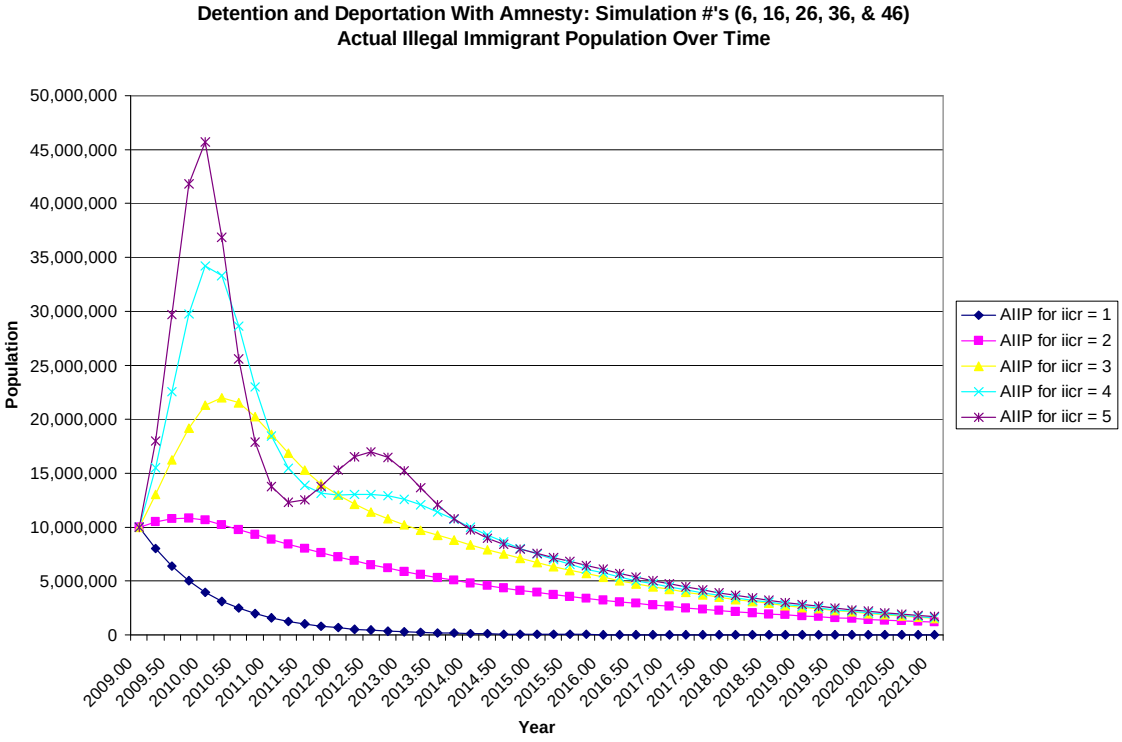

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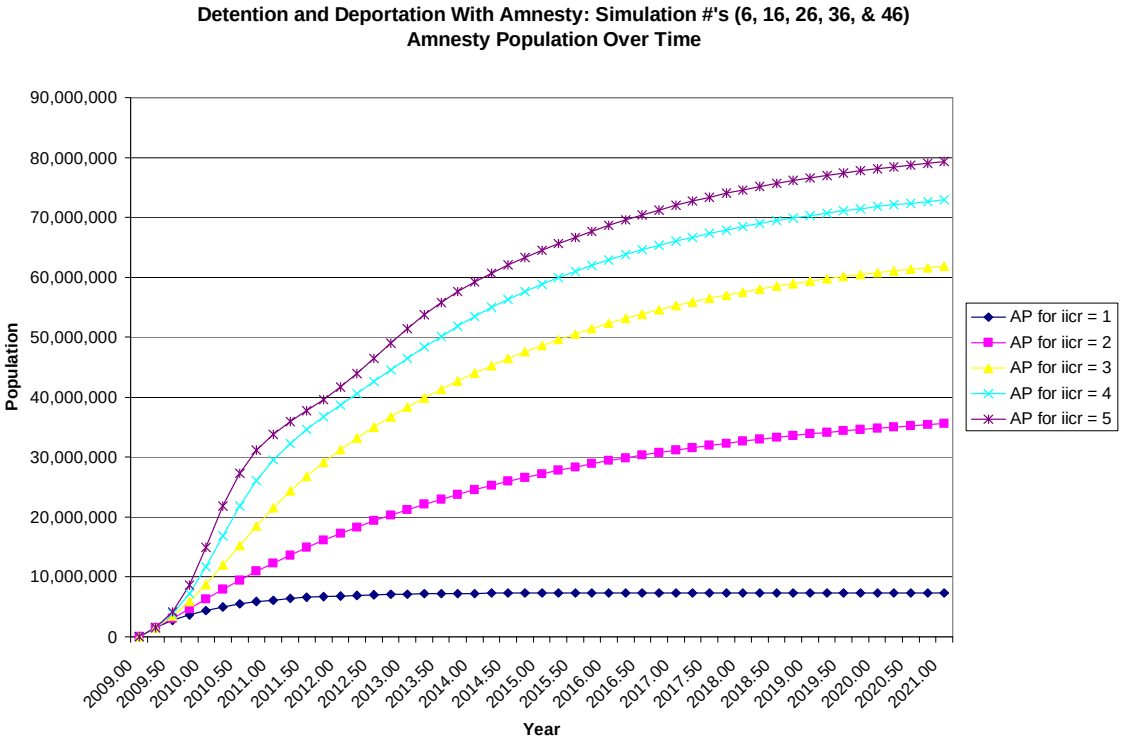

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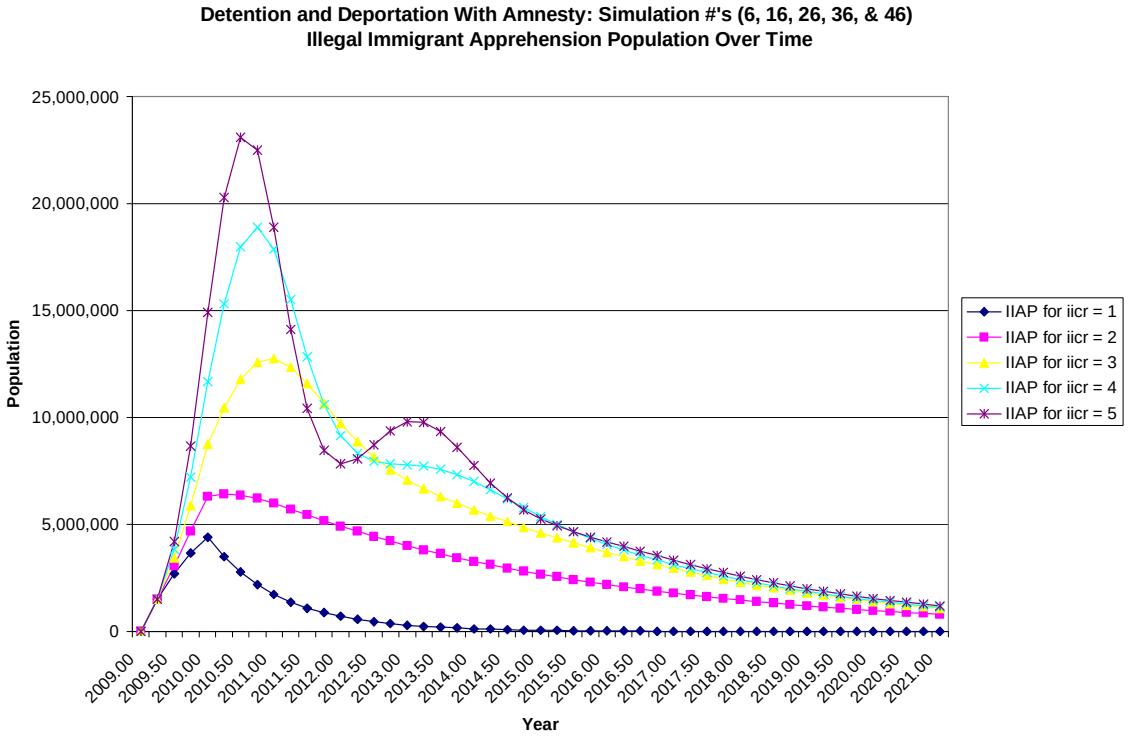

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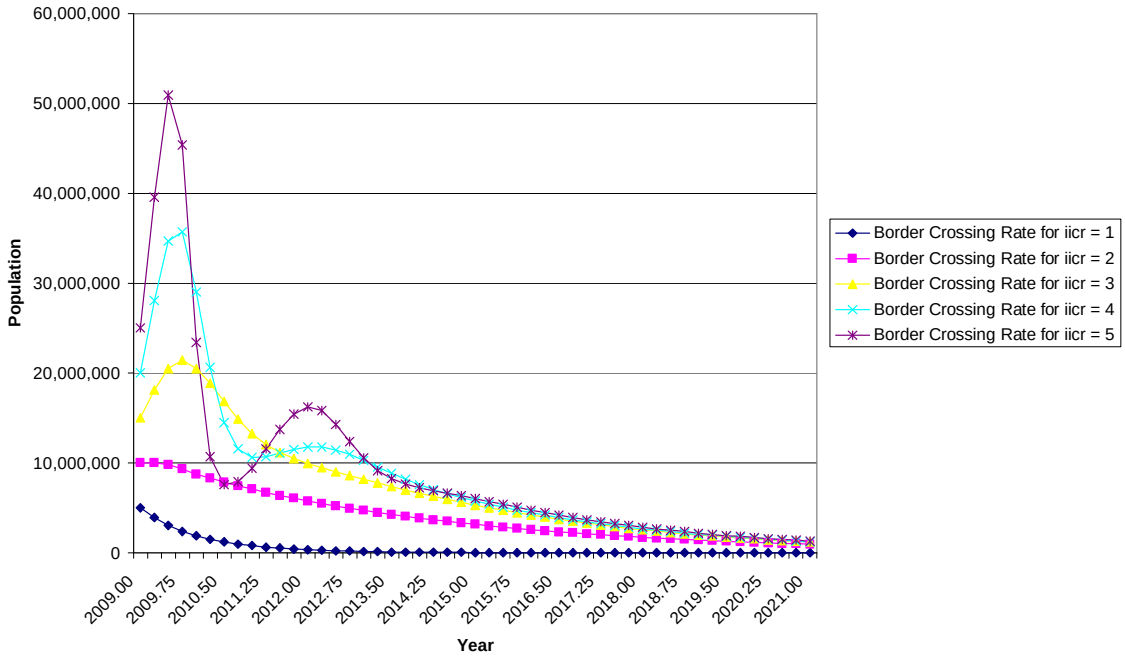

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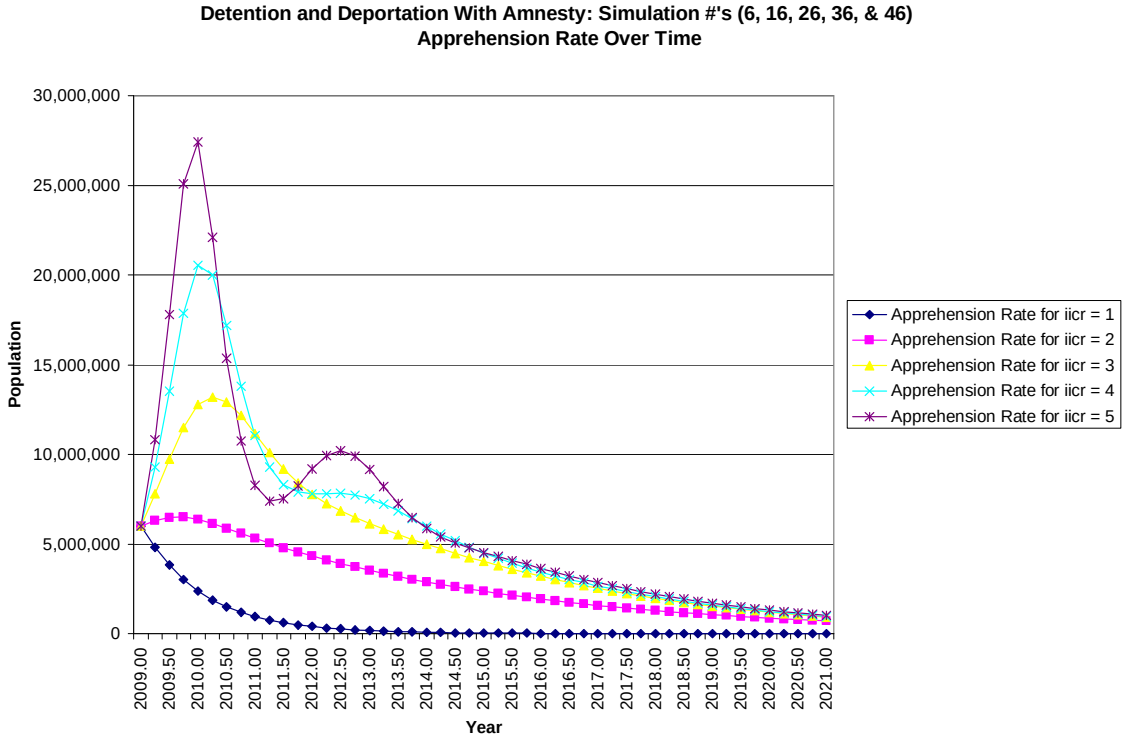

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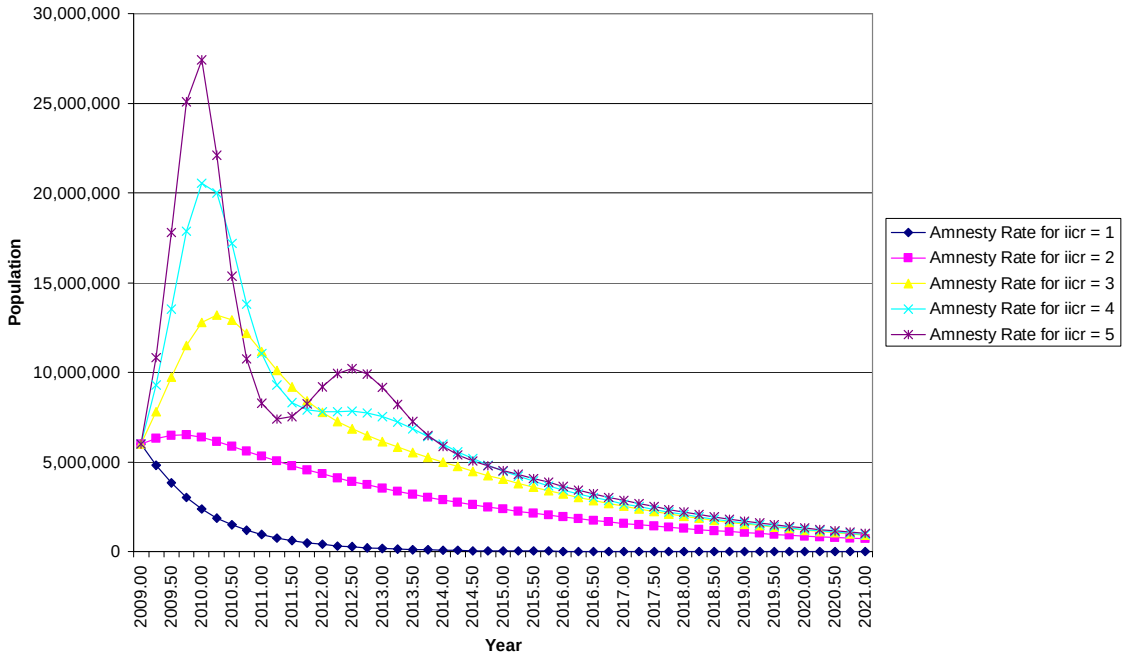

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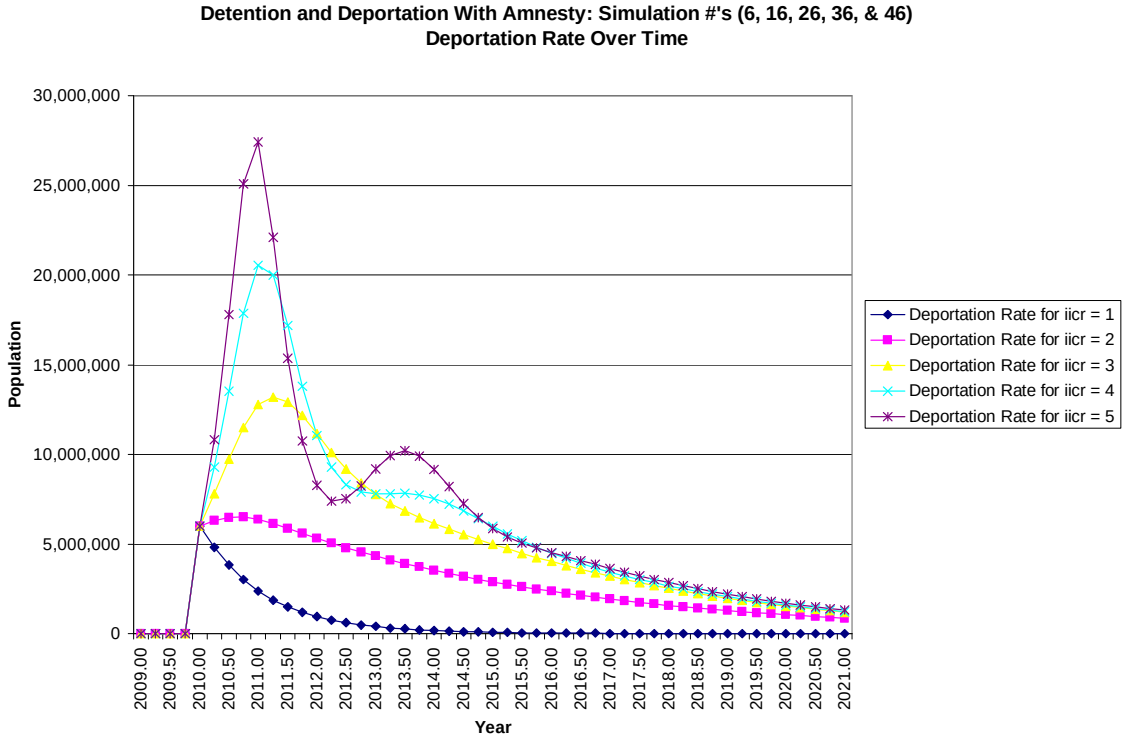

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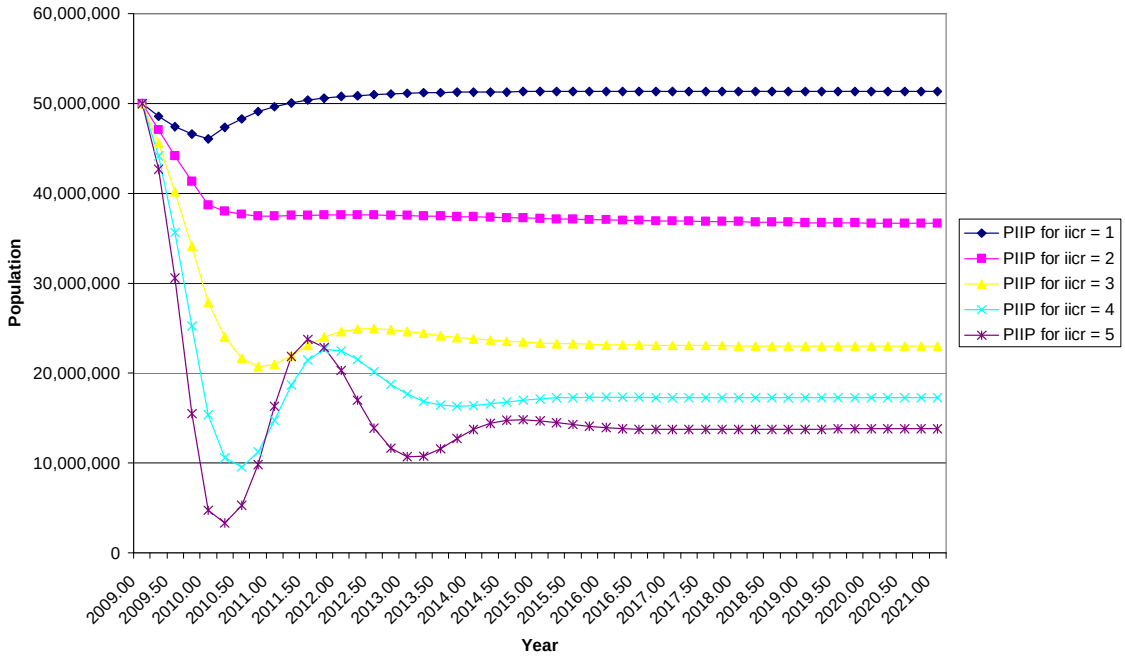

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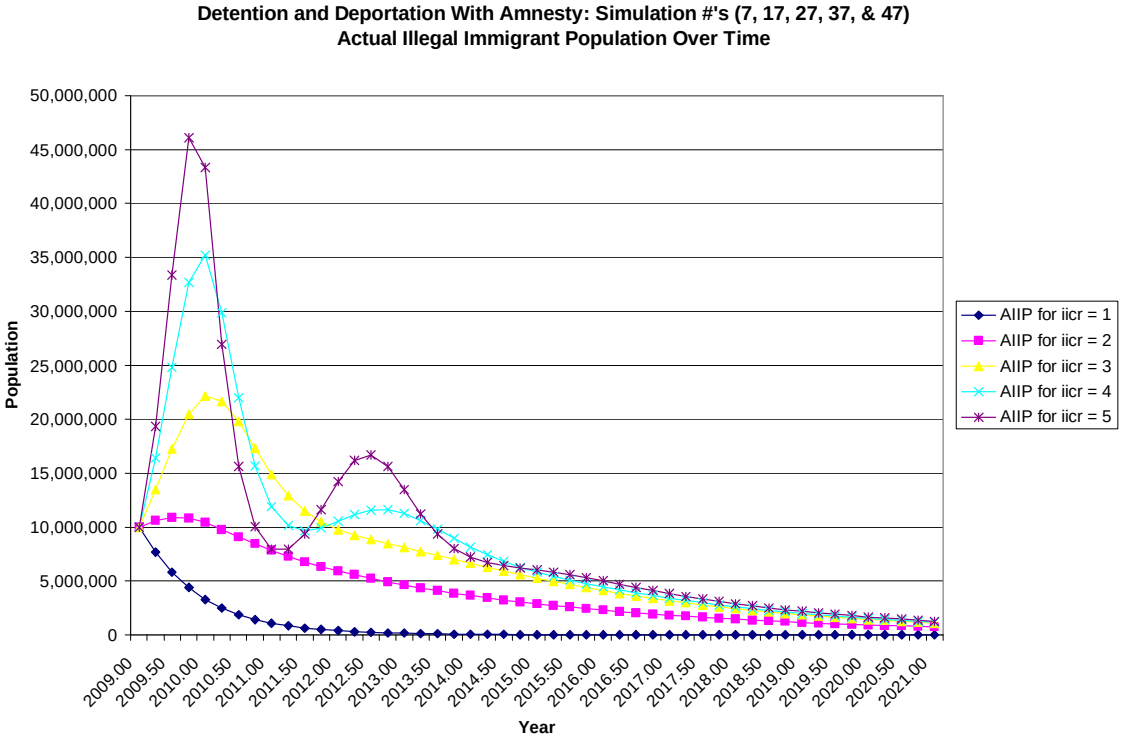

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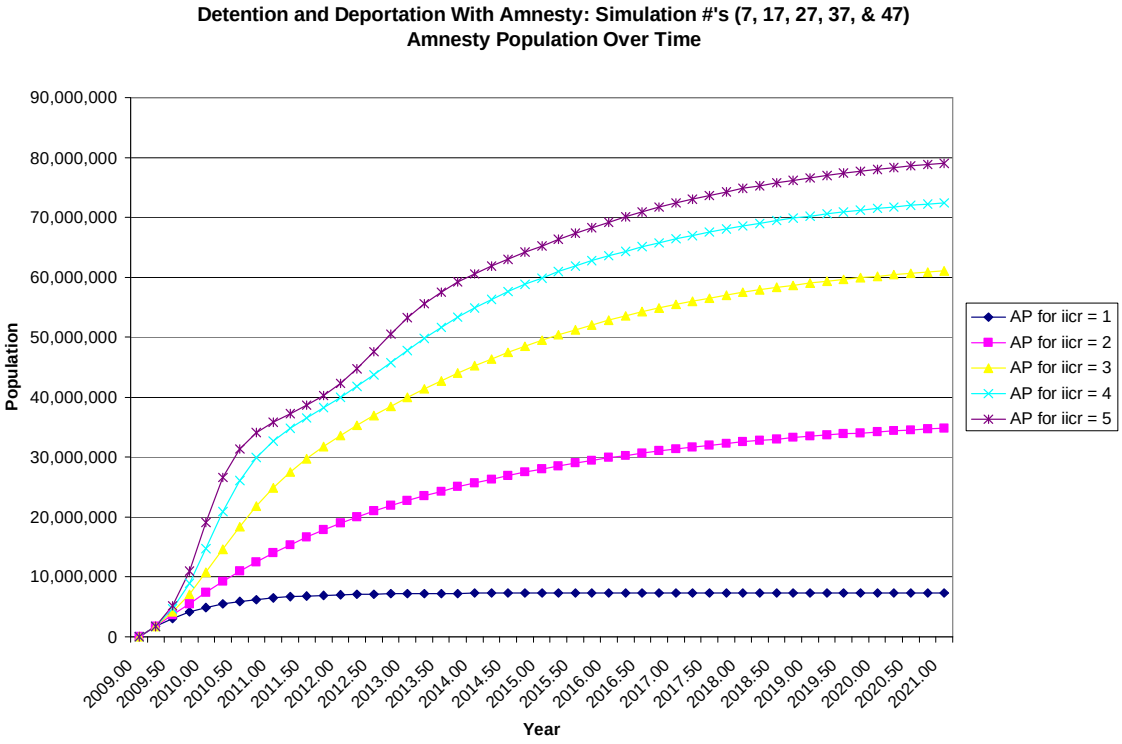

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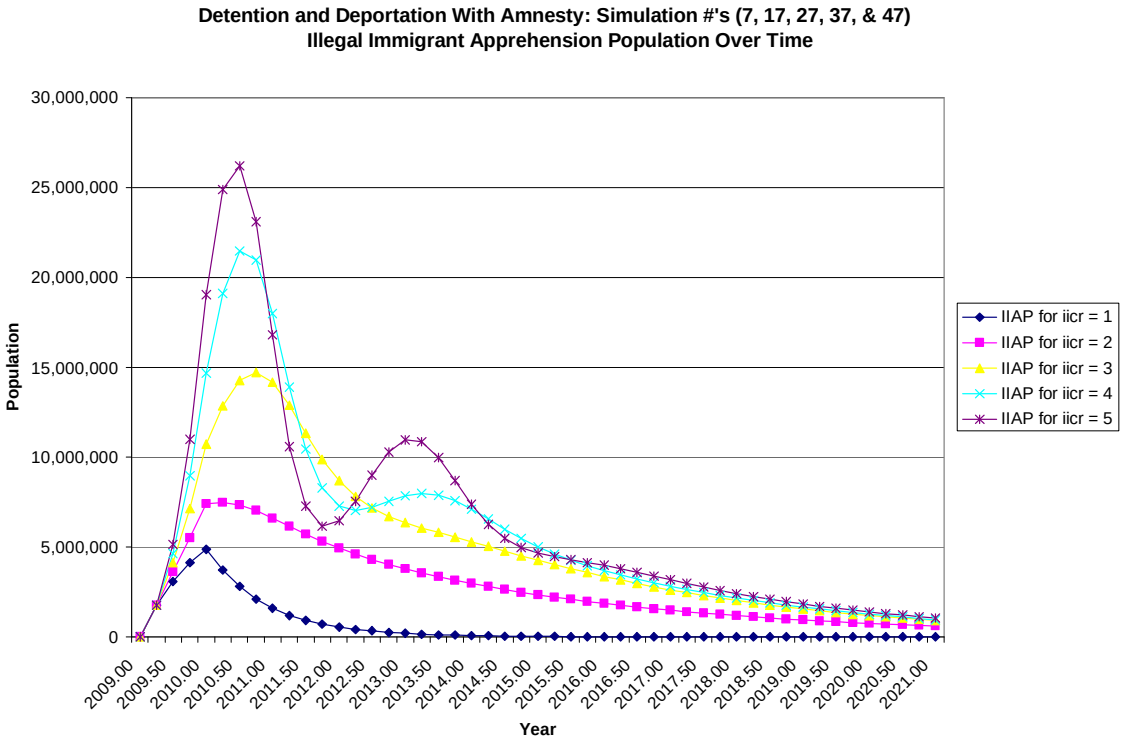

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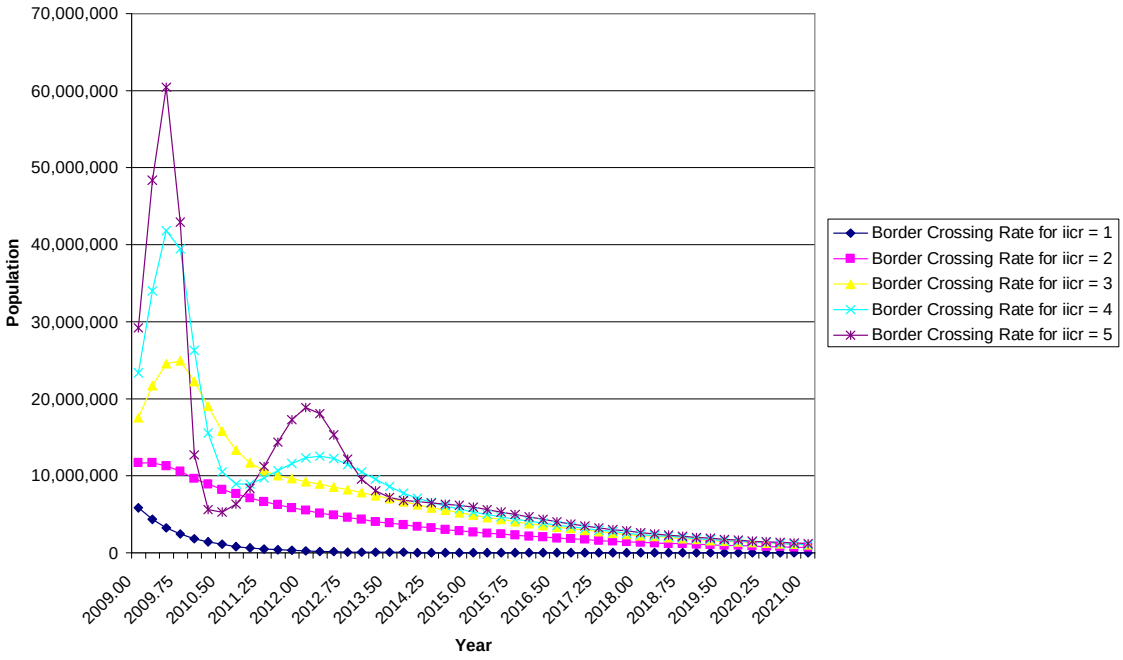

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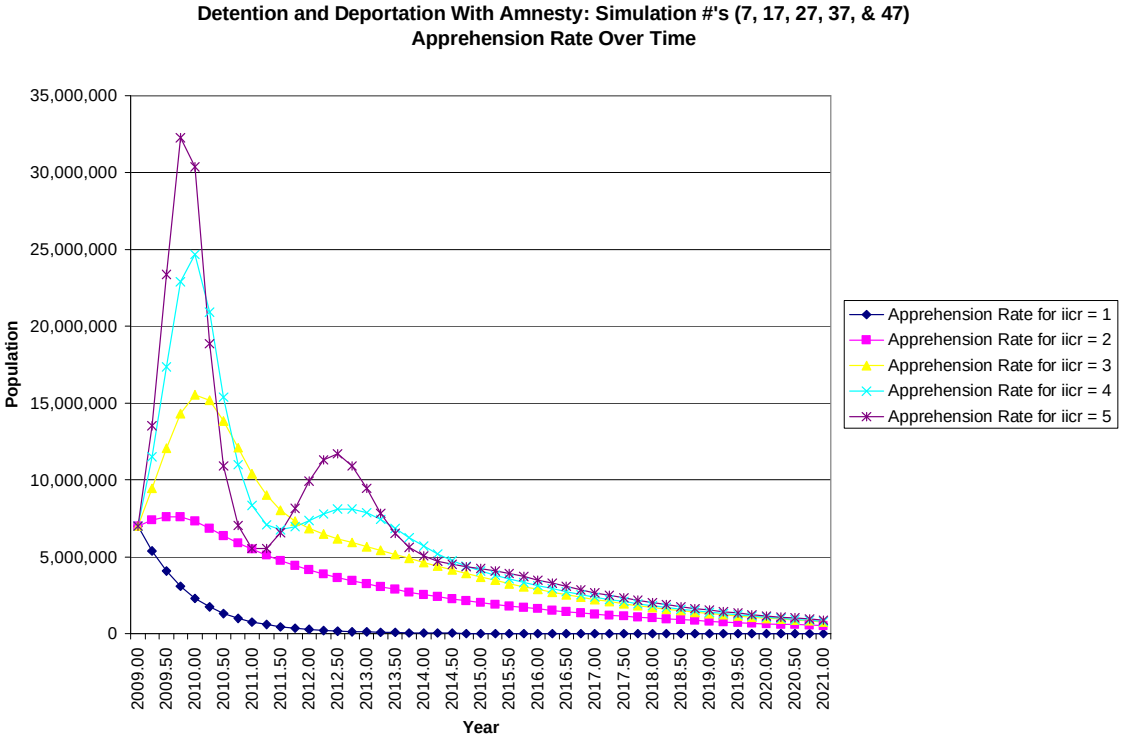

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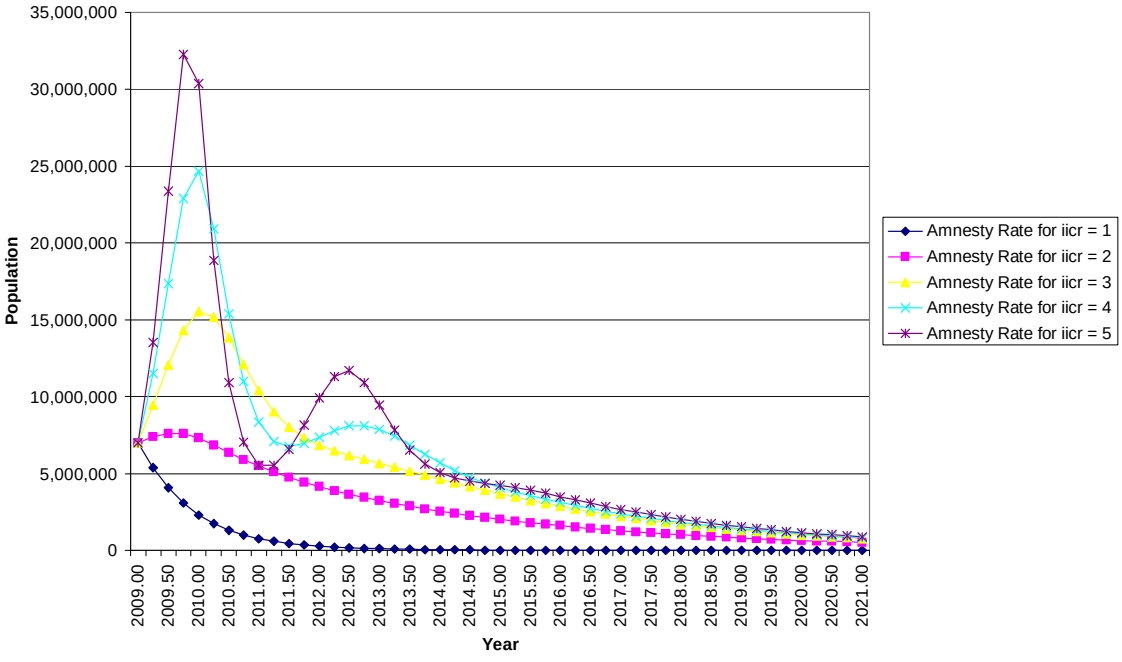

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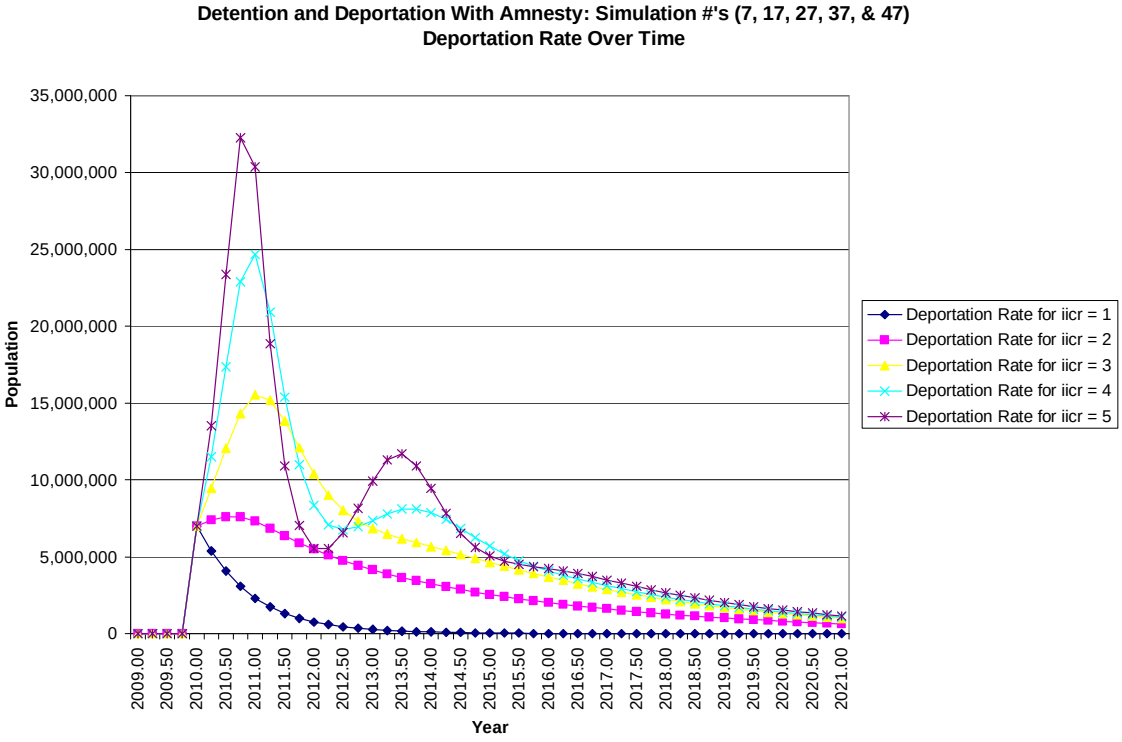

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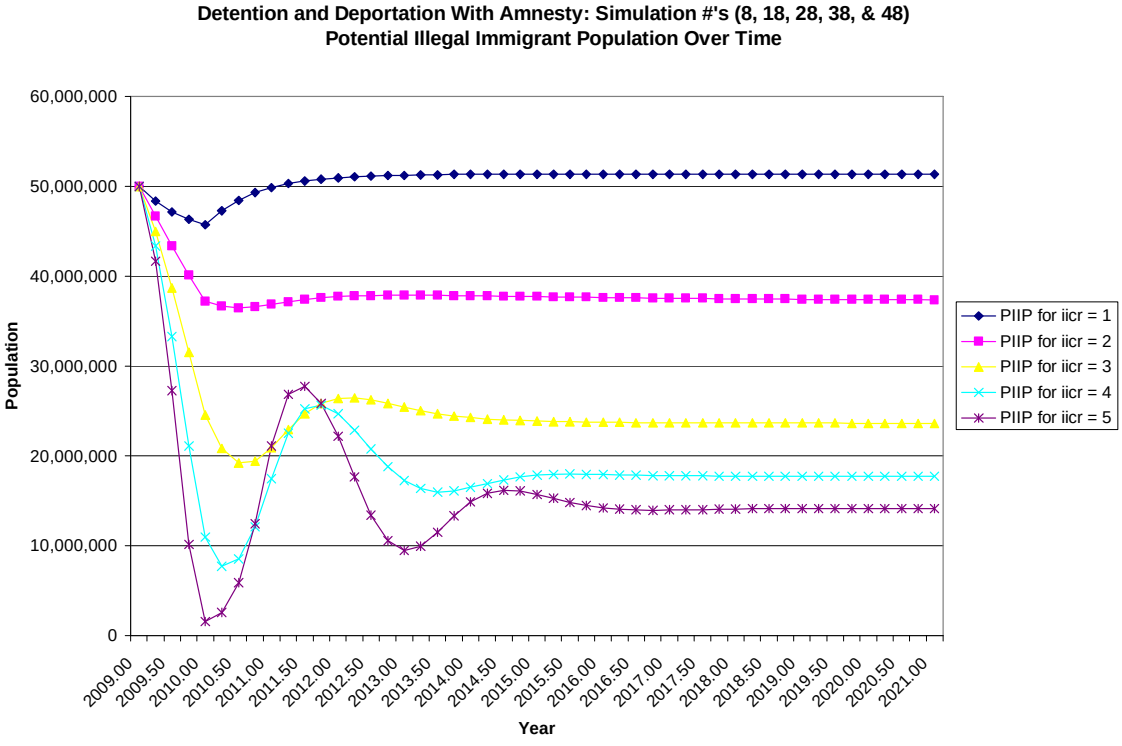

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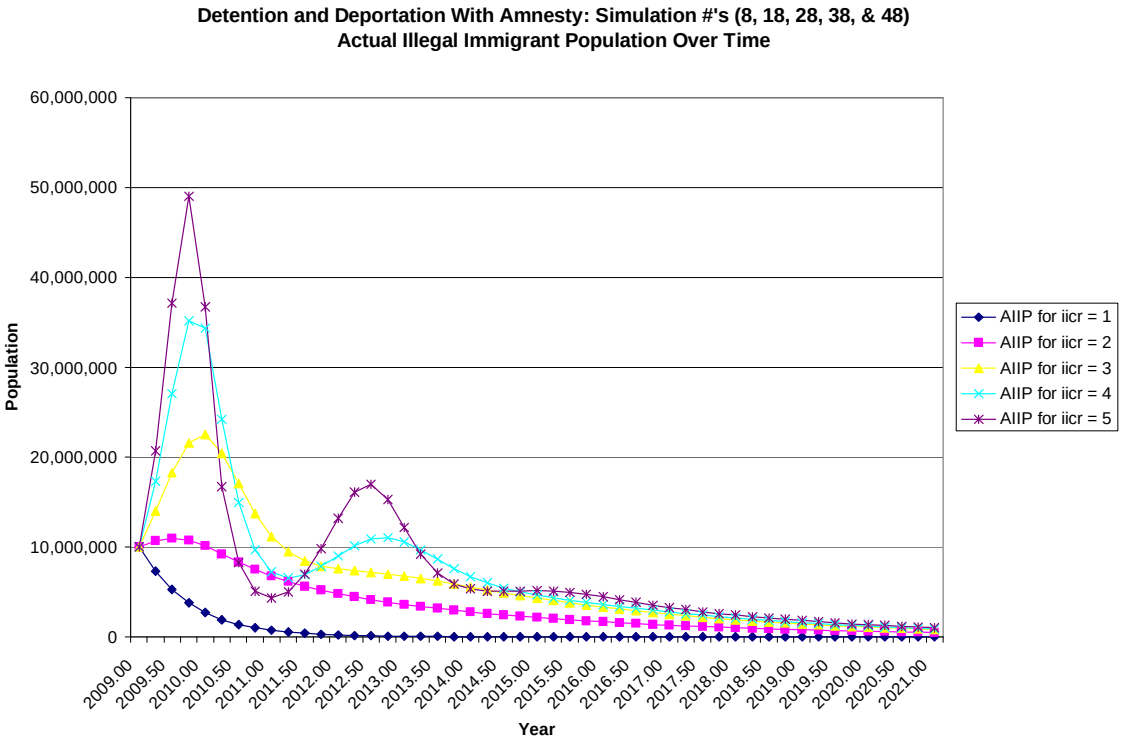

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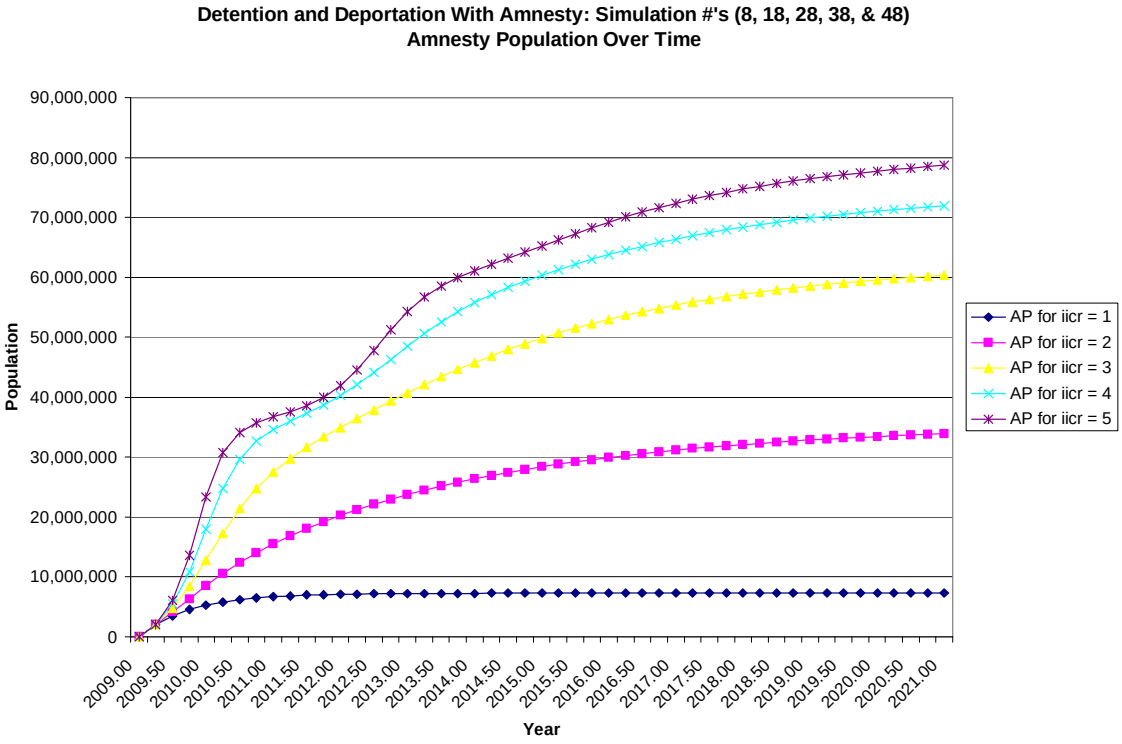

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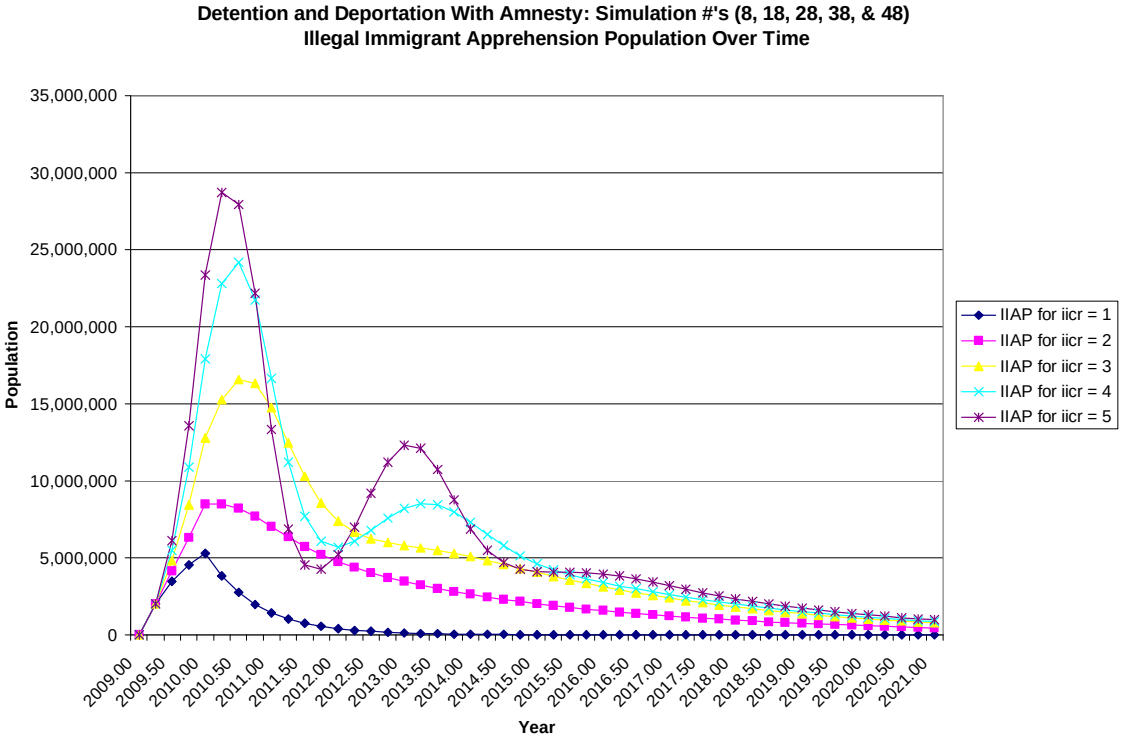

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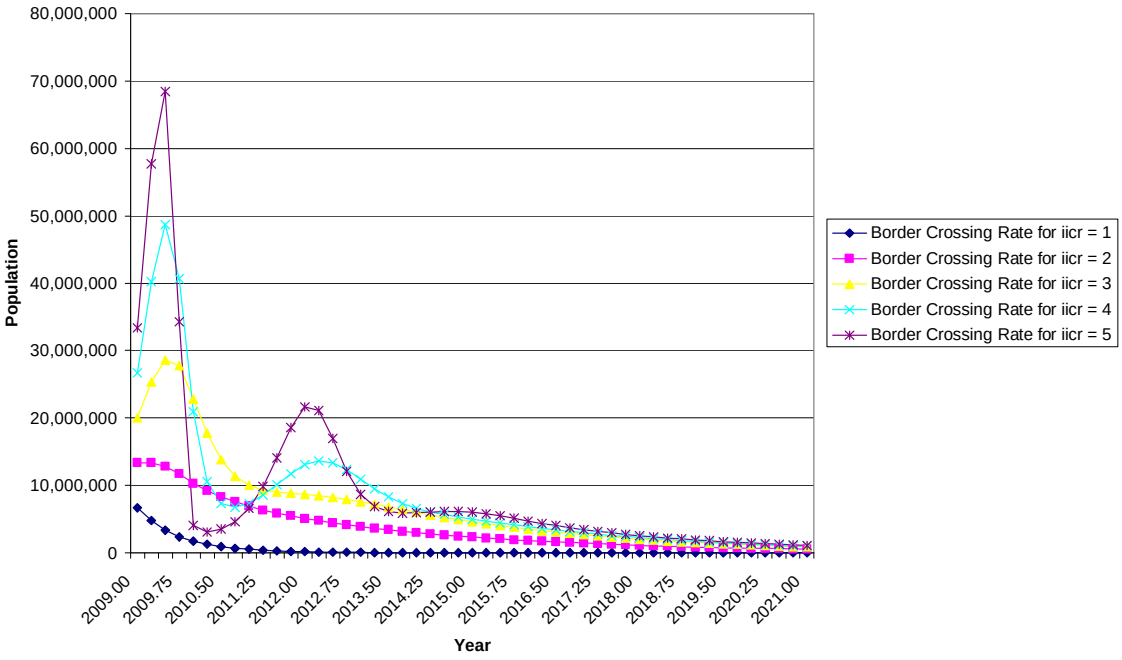

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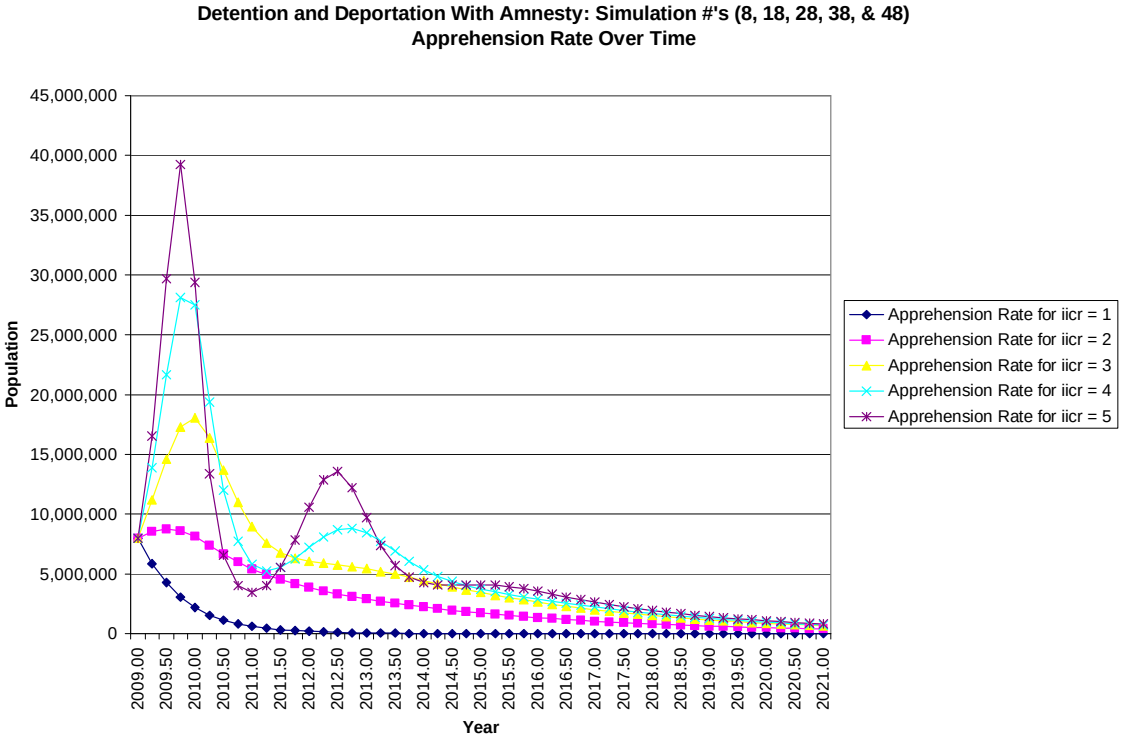

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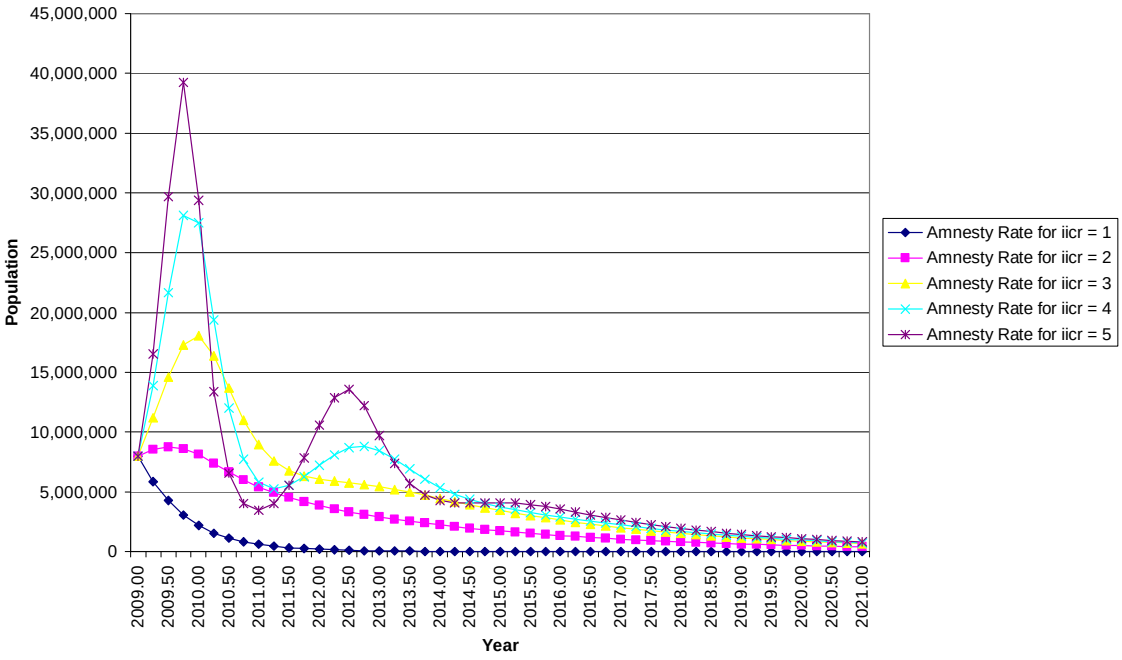

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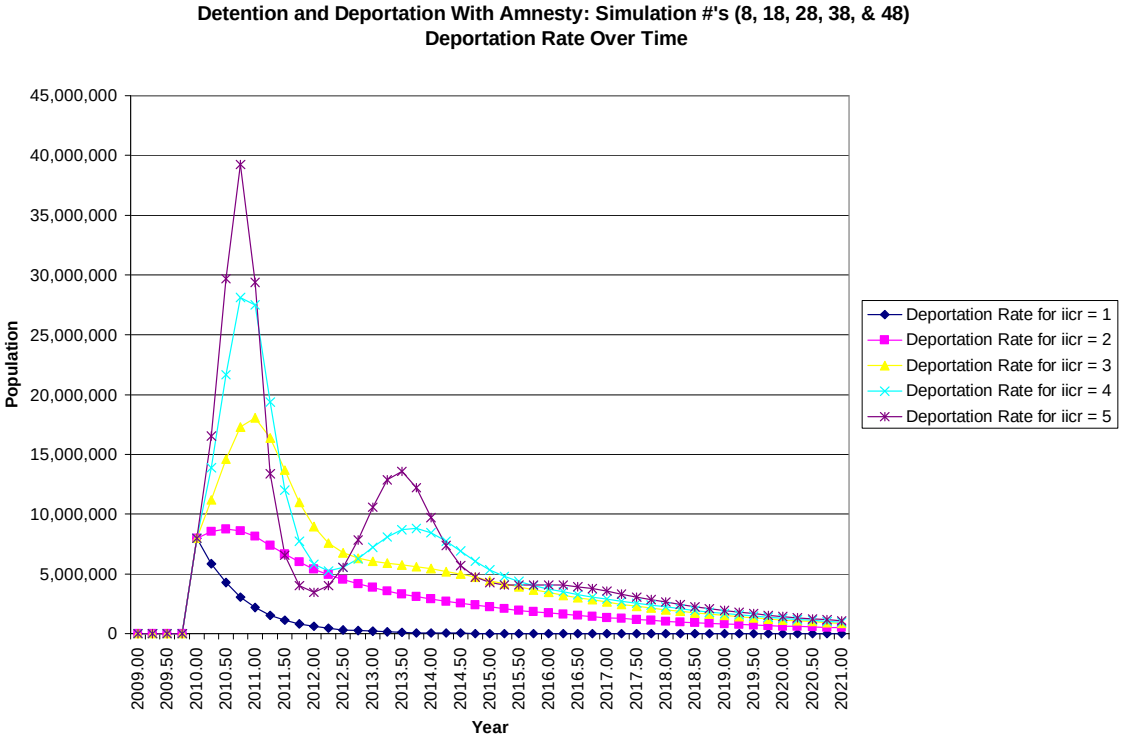

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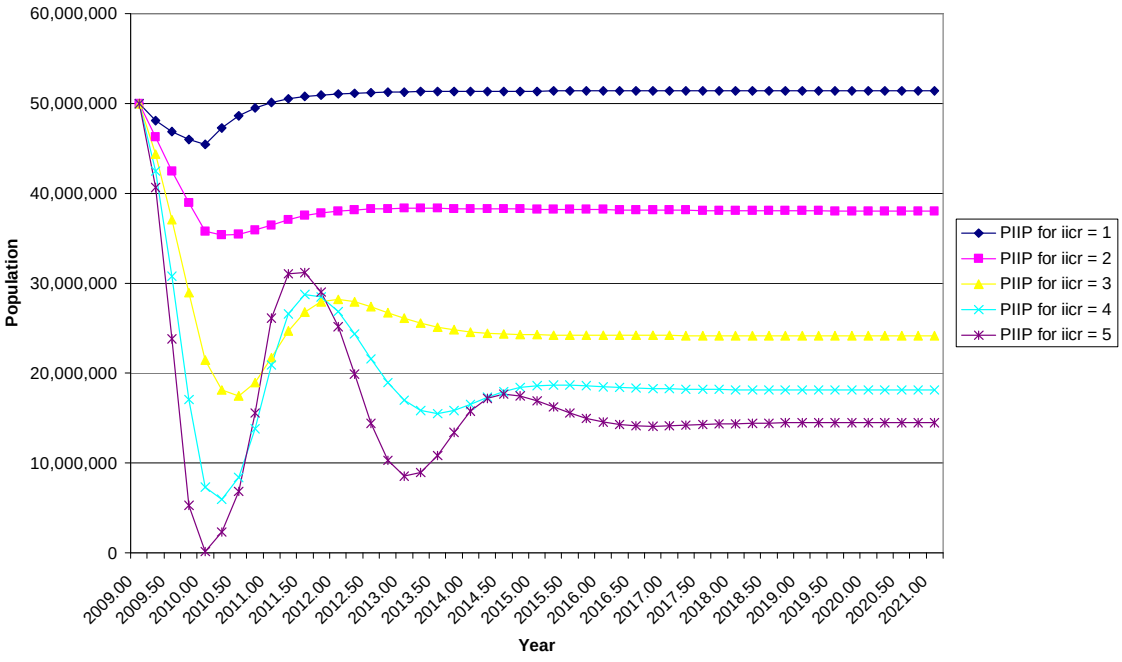

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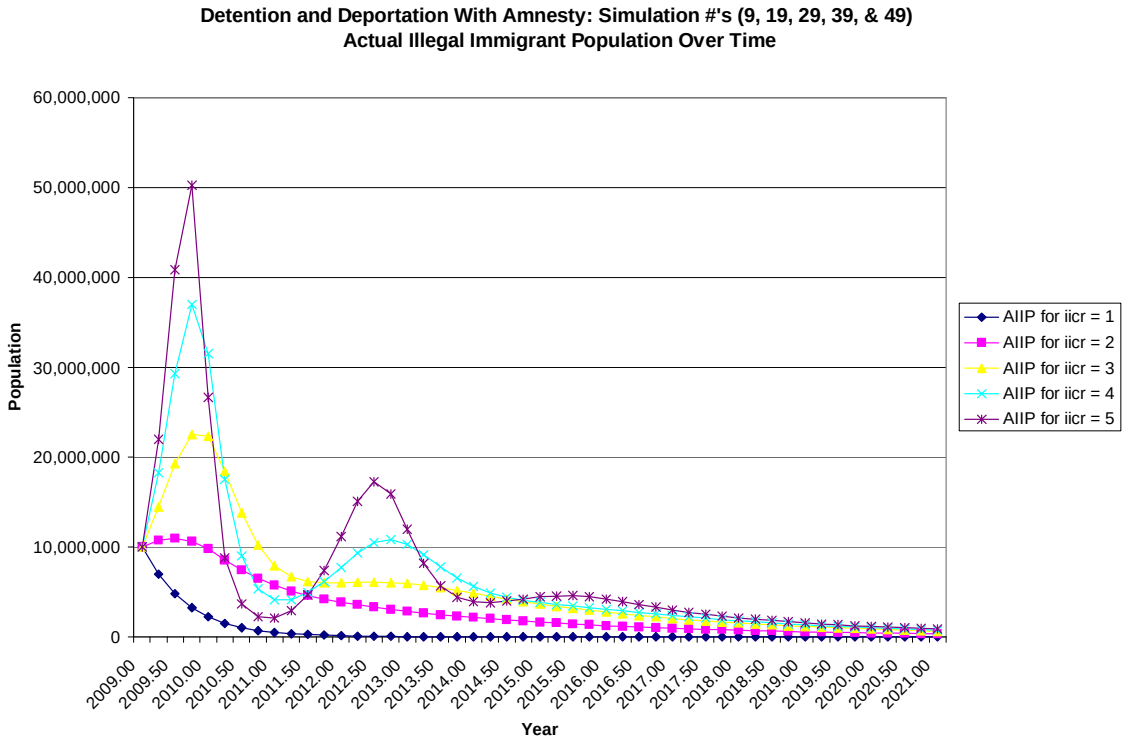

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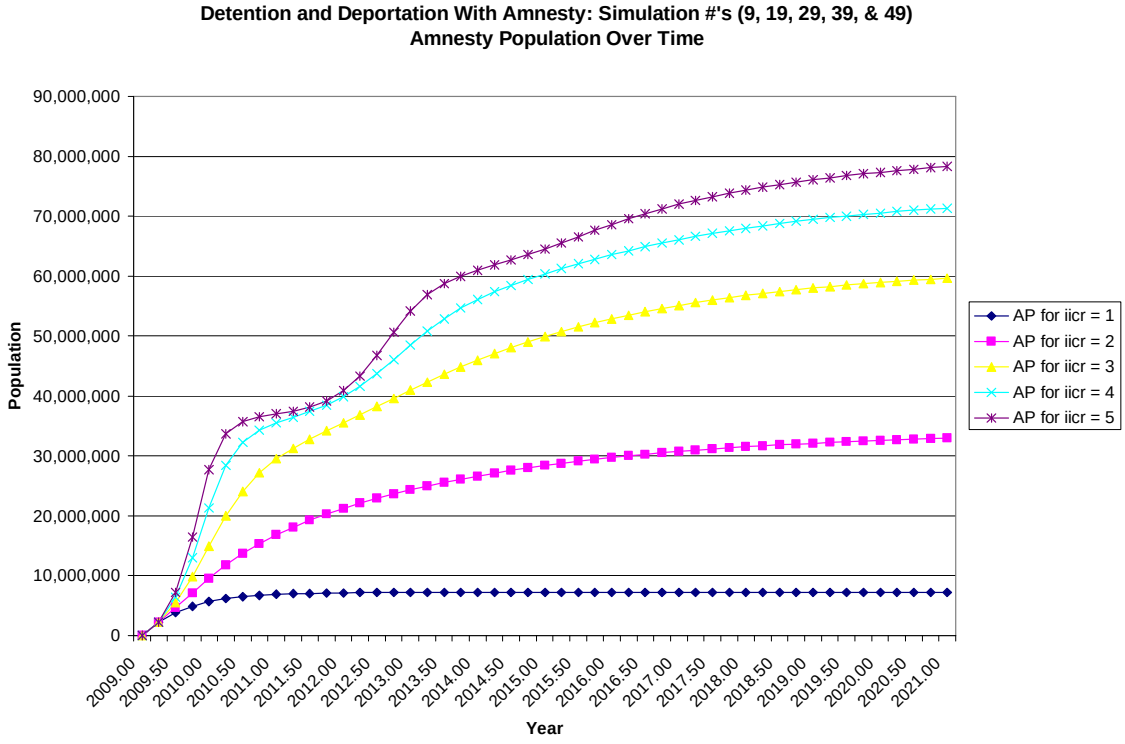

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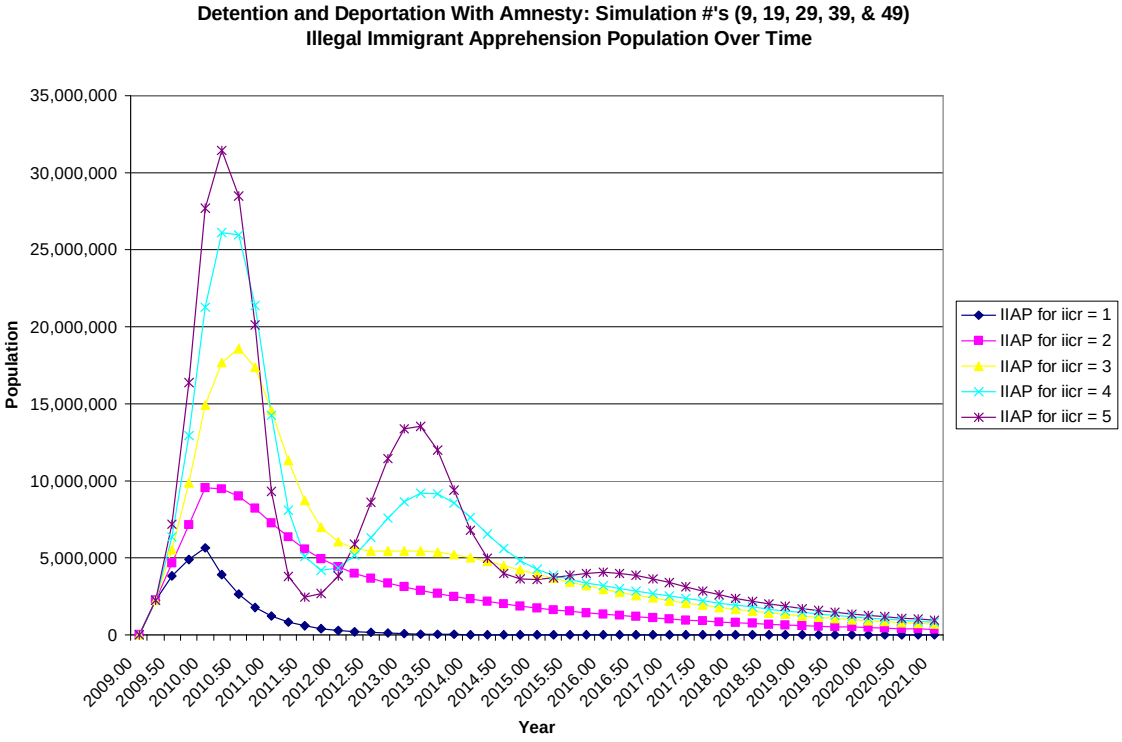

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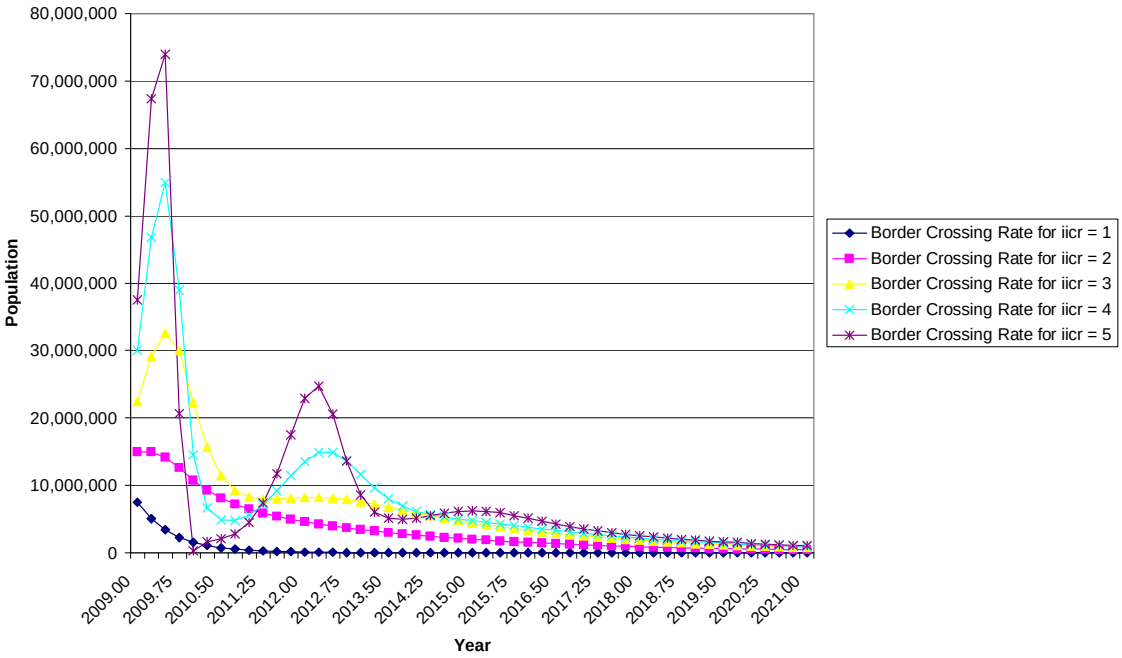

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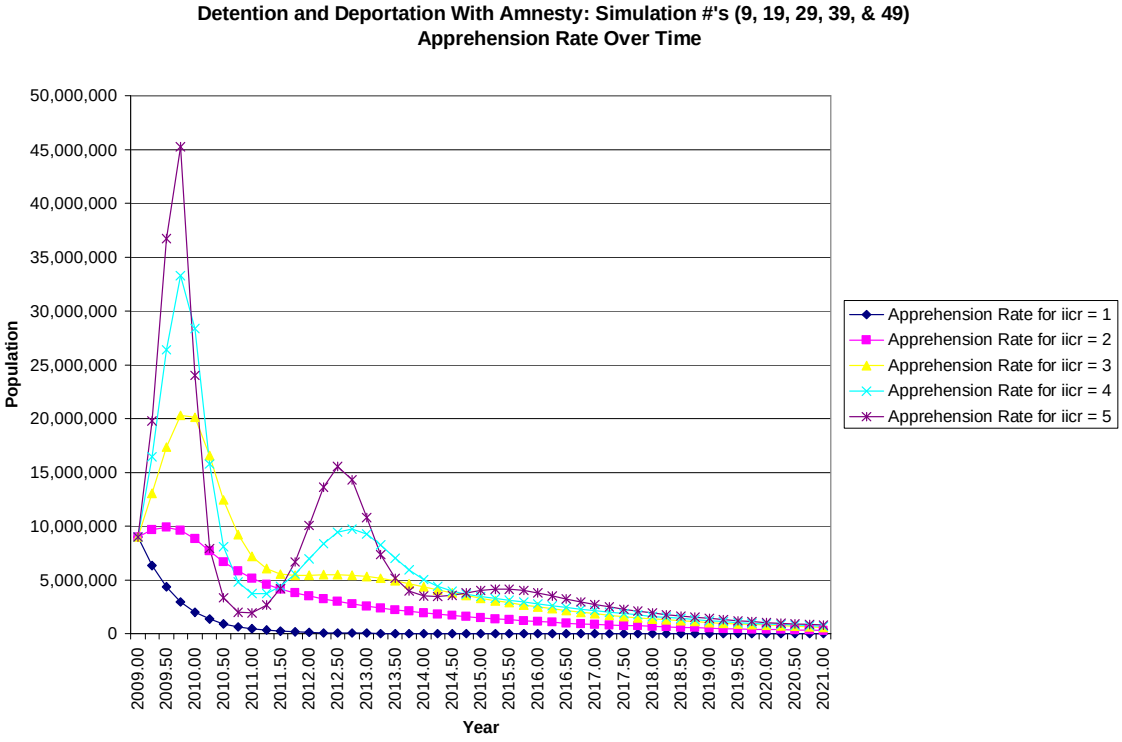

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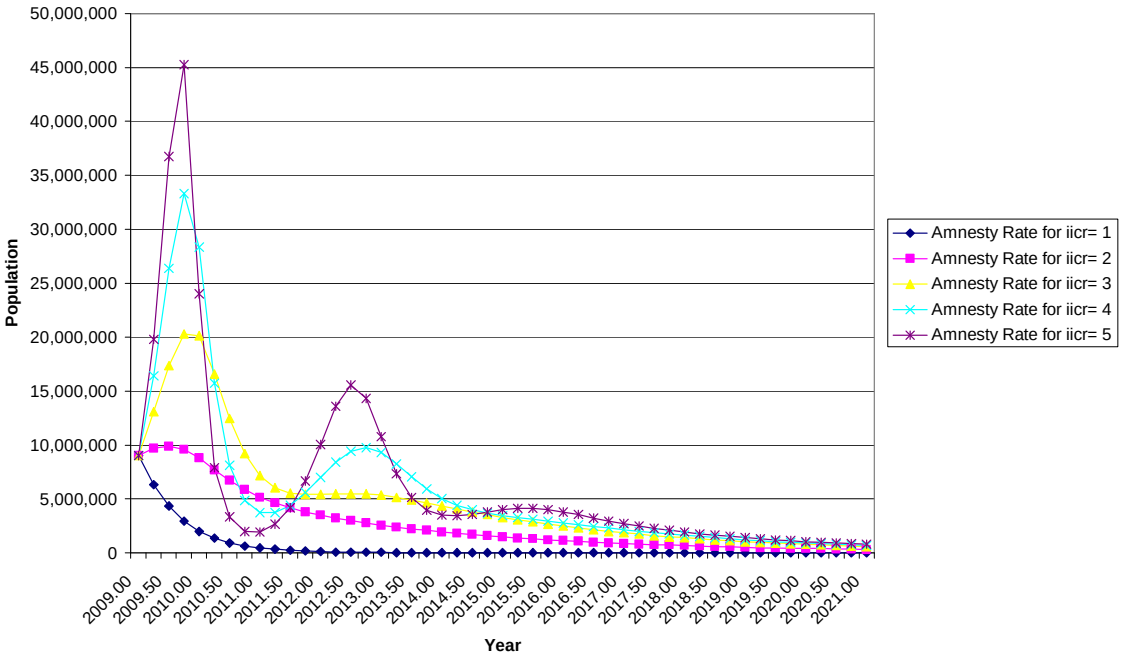

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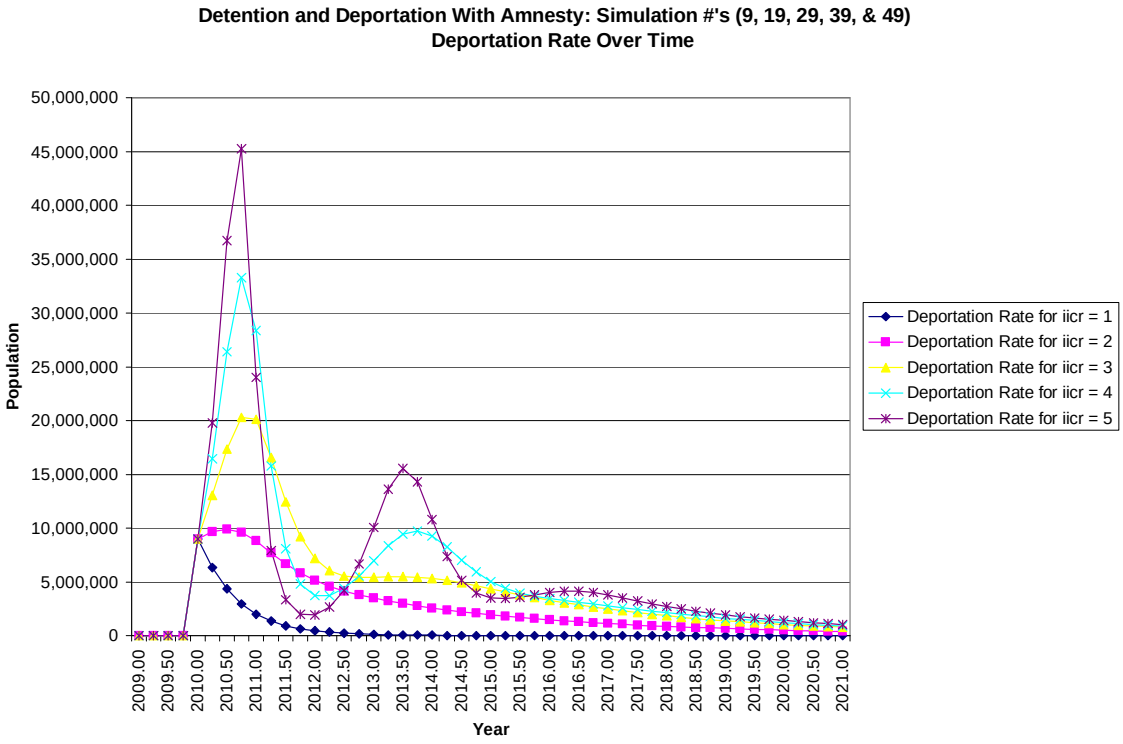
Detention and Deportation With Amnesty: Simulation #'s (9, 19, 29, 39, & 49)
Deportation Rate Over Time
Population
50,000,000
45,000,000
40,000,000
35,000,000
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
2009.00
2009.50
2010.00
2010.50
2011.00
2011.50
2012.00
2012.50
2013.00
2013.50
2014.00
2014.50
2015.00
2015.50
2016.00
2016.50
2017.00
2017.50
2018.00
2018.50
2019.00
2019.50
2020.00
2020.50
2021.00
Year
Deportation Rate for iicr = 1
Deportation Rate for iicr = 2
Deportation Rate for iicr = 3
Deportation Rate for iicr = 4
Deportation Rate for iicr = 5

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