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Chicago Recovery Partnership Evaluation of the American Recovery and Reinvestment Act

Practicum Report

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Preface

The Recovery Partnership is the City of Chicago's collaboration with the Chicago philanthropic community to secure funding and provide strategic guidance in allocating funds from the American Recovery and Reinvestment Act (ARRA) of 2009. The Partnership sought assistance in conducting an evaluation of the impacts of ARRA funding in Chicago, and this report presents the work of the Harris School students who conducted this evaluation. Through the Harris School's policy practicum program, graduate students in public policy worked on this project under the guidance of James H. Lewis, Senior Program Manager at the Chicago Community Trust; Alexander Gail Sherman of the Civic Consulting Alliance; and Paula R. Worthington, Senior Lecturer at the Harris School of Public Policy Studies.

Executive Summary

From 2009 – 2011, the City of Chicago and Cook County received a total of $2.35 billion in funding provided by the American Recovery and Reinvestment Act [ARRA]. The stimulus money was allocated to seven areas: education, basic needs, transportation & infrastructure, housing & energy, public safety, broadband and workforce development. The Chicago Recovery Partnership Evaluation of ARRA analyzes the impact of the stimulus spending using a cost-benefit analysis framework. This report evaluated $1.09 billion of total spending in Chicago and Cook County, resulting in net benefits ranging from -$173.9 to $2,740.2 million. The wide range in net benefits is attributed largely to education, which received over half of ARRA funding.

Introduction

In February 2009, the United States Congress enacted the American Recovery and Reinvestment Act (ARRA) as a response to the recession that began in December 2007. The stimulus package was intended to create jobs and promote investment and consumer spending. All the interventions (tax incentives, expansion in unemployment benefits and welfare programs, and spending in education, health care, infrastructure, etc.) amounted to $787 billion in stimulus investments. The City of Chicago created strategy teams in seven specific areas: education, basic needs, transportation & infrastructure, housing & energy, public safety, broadband and workforce development to obtain and effectively disburse the available funds. In total, the City of Chicago and Cook County received $2.35 billion in funding, from which $468 million were awarded competitively. Chicago received the second highest level of ARRA funding of all U.S. cities.

In April 2009, Mayor Richard Daley invited Chicago-based foundations to join the city in establishing the Recovery Partnership. The City of Chicago has partnered with the Chicago Community Trust and Civic Consulting Alliance to organize, staff, and manage the recovery efforts. As a part of ongoing efforts to increase transparency in policy making, the Recovery Partnership wished to examine the effects of ARRA in Chicago through a large-scale cost-benefit analysis. This report contains cost-benefit analyses on programs totaling $1.09 billion of funding in six categories (excluding broadband). Each of these six sections tracks ARRA spending for its specific area, provides a thorough literature review, outlines the cost-benefit methodology, and summarizes the net value derived from the programs' implementation.

Chapter 1. Basic Needs

1. Introduction

1.1. Education

The American Recovery and Reinvestment Act allocated funds via grants to Education programs that totaled more than $869 million. The funds were allocated to the following eight programs: Head Start, Title I funds, McKinney-Vento Homeless Education, National School Lunch Assistance, State Fiscal Stabilization Fund (SFSF) in 2009 and 2010, IDEA fund and Teacher Incentive fund.

According to the City of Chicago's Recovery website, stimulus money related to education would be used with the goal of: "Promoting innovation and excellence, recruiting, preparing, and rewarding outstanding teachers, encouraging better standards and assessments and investing in early childhood initiatives and college and career preparedness". This also included funding teachers' salaries and expanding coverage of existing programs like Head Start.

The largest percentages of funds were SFSF funds. SFSF is a one-time allocation of $53.6 billion from the federal government to states under ARRA. The funds are appropriated through two types of block grants to that are: 1) earmarked for education; 2) other governmental services. States have significant autonomy in how they distribute funds to their state and local education budgets, with a general goal in mind: keep budgets for K-12 and higher education from dropping below FY2006 levels. The Chicago Public School system was allocated $261.05 million in FY2009, and $166.72 in FY2010. While no jobs were "created" using this funding, a high percentage of these funds were dedicated to paying teacher salaries in order to prevent layoffs.

Title I, Part A funds constituted the second largest amount. The ARRA provided the Illinois State Board of Education with an allocation for Title I Part A of $420.15 million in addition to the regular Title I appropriations for FY2010. The Chicago Public School system was awarded $261.61 million out of the total allocation for Illinois. Specific programs and projects to be funded in Chicago include: teacher support and professional development, parental involvement programs, administrative costs, additional after school programming and one-on-one tutoring, pre-K and early education programs, technology to drive student achievement, college and career preparedness.

IDEA, Part B funding for Preschool and Special Education Flow Through was $119.2 million, making it the third largest program funded by the ARRA in Education. Preschool funding provides grants to States, to provide special education and related services for children with disabilities aged 3 through 5. States may include children experiencing developmental delays and 2-year olds who will turn 3 during the school year. Funding under the Preschool Grants program supports early childhood programs that provide services needed to prepare young children with disabilities to enter school ready to learn. According to the US Department

of Education (2010b) Special Education Flow Through funding provide grants to ensure a free, appropriate public education for children with disabilities that meets challenging standards and prepares them for higher education, employment, and independent living.

The Teacher Inventive Fund received $42.2 million in ARRA funds. The program's goals include: "improving student achievement by increasing teacher and principal effectiveness, reforming teacher and principal compensation systems so that teachers and principals are rewarded for increases in student achievement, increasing the number of effective teachers teaching poor, minority, and disadvantaged students in hard-to-staff subjects and creating sustainable performance-based compensation systems" (US Department of Education, 2010).

The other two programs funded were the National School Lunch Program Assistance ($1.5 million) and the McKinney-Vento for Homeless Children and Youth ($1.1 million). The goal of the School Lunch Program is for children to have access to nutritional food, helping them thrive in the classroom and in life. McKinney-Vento program provides services to homeless children to ensure they continue attending school.

Given the variety of programs we chose to focus our analysis on evaluating the impact of SFSF and Title one funds dedicated to pay for teachers' salaries, and thus prevent teachers' layoffs, due to the large percentage these funds represent from the total ARRA funds dedicated to Education.

1.2. Basic Needs

The goal of providing funding for Basic Needs, Health and Human Services, was to improve the quality of life for those residents of Chicago who need it most. With a focus on the homeless, children and low-income individuals and families the funding was dedicated to programs that focused on these communities.
The stated goals of the Basic Needs group as found on the City of Chicago website are[1]:

- Expansion of services for children through additional slots in Head Start, Early Head Start and Child Care Assistance Program
- Expansion of services for youth through summer employment opportunities, scholarships, engagement of homeless youth; and case management, substance abuse and mental health services for youth involved in the criminal justice system
- Expansion of services for low income residents, including the homeless, through housing placement and stabilization, public benefits outreach and enrollment, counseling and case management, substance abuse and mental health services, and targeted outreach to the chronically homeless
- Expansion of workforce development services including targeted services for veterans, homeless persons, and expanded service delivery at Community Service Centers

[1] "City of Chicago :: Basic Needs (Health & Human Services)." *City of Chicago*. Web. 28 March 2011. <http://www.cityofchicago.org/city/en/progs/recovery_reinvest/education3.html>

- Expansion of Services for seniors through nutrition and job training programs
- Stimulating the local economy through the creation of jobs in the human services sector

The Chicago Recovery Partnership report of October 2010 reports that almost $70 million dollars was awarded to the Basic Needs group, with $90 million being requested.[2] The programs receiving the largest amounts of funds were Homeless Prevention and Rapid Re-Housing, Head Start/Early Head Start, Community Services Block Grants, and Immunizations.

The programs the basic needs team focused on for analysis were Homelessness Prevention and the Head Start/Early Head Start program. These programs were chosen because they received significant amounts of money and/or were of specific interest to the team based on their potential for producing high-impact results. The funding for these programs would not have existed were it not for the ARRA grants, receiving these funds allowed the City of Chicago to explore and test the viability of these programs without risking a loss of existing city funds.

1.2.1. Homeless prevention

The Homeless Prevention and Rapid ReHousing Program is administered through the U.S. Department of Housing and Urban Development (HUD). Approximately $34 million was awarded to the City of Chicago to provide financial assistance and services to families that are homeless or are at risk of becoming homeless. Of the total funds awarded, $23 million are dedicated to providing direct financial assistance to Chicago residents and will be used to provide short and medium term rental assistance, security deposits, utility payments, moving assistance, and motel vouchers. The remaining $9 million have been set aside for housing relocation and stabilization services that include case management, outreach, housing search and placement, legal services, mediation and credit repair.

To measure the impact of the $34 million spent on Homeless Prevention and Rapid Re-Housing, our team collaborated with the Emergency Fund, a non-profit whose mission is to provide immediate financial assistance to help low-income individuals and families through a crisis or transition. The Emergency Fund was the largest recipient of ARRA funding for Homeless Prevention and Rapid ReHousing receiving $24 million dollars, of which $23 was dedicated to direct financial assistance.

The Emergency Fund will be distributing the ARRA funds over a period of three-years to individuals and families at risk of becoming homeless. This is a short-term program, and all people who enter it must be willing and eventually able to pay for their unit when the assistance ends, as this is not a subsidized housing program.

1.2.2.Head Start Early Head Start

[2] "Recovery Partnership Final Report." *City of Chicago :: Recovery and Reinvestment (Stimulus)*. Web. 22 May 2011. <http://recovery.cityofchicago.org/etc/medialib/stimulus_site/pdf_s/stimulus_scorecard.Par.36329.File.dat/RecoveryPartnershipFinalReportNov2010.pdf>.

We evaluated Head Start funds dedicated to expansion of coverage due to critical role early childhood education plays in the future success of disadvantaged children. Three types of ARRA funding, totaling $16.4 million, were allocated for Head Start and Early Head Start: Expansion, Quality Improvement (QI) and Cost-of-Living Adjustment (COLA). The goal of the Expansion funding ($7.8 million) was to provide 590 low-income families and their children up to age 5 with early childhood education and other support services. QI funding would mainly provide greater professional development resources for teachers while COLA funding would provide cost of living increases for Head Start/Early Head Start staff. QI and COLA funding amounted to $8.6 million. A much smaller amount of funding, $225 thousand, was awarded to provide technical assistance for these programs.

Title I & SFSF Funds

2. Literature Review

Title I and the State Fiscal Stabilization Funds (SFSF) make up a substantial amount of the total the American Recovery and Reinvestment Act (ARRA) funds allocated to education, together totaling $688.38 million. Both grants are vast in scope and the states have substantial flexibility about where to spend the money. A Report to Congress by the Government Accountability Office (GAO) in December 2009 reports that about 60 percent of the State Fiscal Stabilization Funds allocated to Illinois was intended to pay teacher salaries in order to prevent teacher layoffs. The GAO report estimated that approximately 15 percent of Title I ARRA funding would be spent on teacher salaries. With those assumptions in mind, we chose to focus first on determining the costs and benefits associated with the 60 percent of SFSF and 15 percent of Title I funds that went to pay teacher salaries.

The ARRA funding that infused the Chicago Public Schools (CPS) budget prevented major layoffs throughout the district. Without these funds, CPS would have had far fewer teachers for the same number of students, pushing up classroom size significantly. The Chicago Defender predicted on June 9, 2010, that putting teachers out of work to close the budget gap could result in a 20 percent increase in class size (Hutson 2010). A review of the State's legislation and Chicago Public School's Policies regarding teachers' layoff shows that layoffs are decided based on seniority of teacher, making the possible effects of a reduction in funds on class sizes stronger.

A wide range of estimates have been made about the effect of class size on student outcomes such as test scores, other achievement measures, and earnings. In November of 2000, economist Caroline Hoxby published the study, "The Effects of Class Size on Student Achievement: New Evidence from Population Variation." She performed an econometric analysis of classes in 649 elementary schools in Connecticut. She used longitudinal data to smooth population variation, and looked at jumps in class size as a result of maximum or minimum class size rule changes. She measured student outcomes by using the log of

standardized tests. Her estimates lead her to conclude that class size does not have any statistically significant effect on student achievement (Hoxby 2000).

Many less conclusive studies have shown mixed results for class size on student outcomes. Joshua Angrist and Victor Lavy used the twelfth century rabbinical scholar Maimonides' "rule of 40" to create an IV to consider the effect of class size. Maimonides' assumption that the class sizes should not exceed 40 students per teacher is important because Israeli education policy has been shaped by the belief (Angrist and Lavy 533). The 40 person maximum induces a non linear and non-monotonic relationship between Israeli public school class size (Angrist and Lavy 533). The statistical model developed on the 40-student maximum inference estimates that reductions in class size are correlated with significant and substantial gains in math and reading achievement for fifth graders, modest improvements for fourth graders, and little improvement for third graders (Angrist and Lavy 569).

A paper published in January 2011 evaluates the long-term impacts of Project STAR, a random control trial experiment performed in Tennessee to determine effects of class size and teacher quality on student outcomes. The paper specifically links the long term effects on earnings for STAR participants and an analysis of variance shows that increased test scores in kindergarten have a significant effect on earnings at age 27 (Chetty et al). The study uses administrative data from tax returns to link class size to kindergarten test scores to earned wages in adulthood (Chetty et al). Thus, the paper associates interventions that increase test scores (namely, reduced class size and improved teacher quality) with the increase in adult wages (Chetty et al 2). Another study of Project Star (Krueger 2002) examines the effects of Class Size on Student Achievement performing an analysis of the existing literature and a Cost – Benefit Analysis of class size reduction. Using this data we were able to estimate how wages were affected by class size so that we could monetize the potential benefits that Title I and SFSF funds will produce by preventing teacher layoffs.

3. Cost-Benefit Analysis Methodology

A key impact measure of class size is students' educational achievement, which is directly correlated with students' lifetime earnings. Therefore, we endeavored to assess how the ARRA funds dedicated to these two programs may have affected these measures.

Evidence strongly suggests that CPS would have been forced to lay off teachers and increase the number of pupils per classroom had it not received these funds. (Hutson 2010) A report by the Government Accountability Office indicates that about 15% of Title I ARRA funds and about 60% of SFSF ARRA funds were used towards teachers' salaries in Illinois (see Annex 1). Based on these figures we estimated that $175.67 million in ARRA funds were used for teachers' salaries (See Table 1).

Table 1. Overview of ARRA Funding Used Toward Teacher Salaries

Program	Total 2009-2011 ARRA Funding Received (Millions)[1]	FY 2009 ARRA funding	% Allocated to Teacher Salaries to Prevent Layoffs	Annual Funding to Teacher's Salaries* (Millions)
Title I	$261.61	$130.8 (Assume 50% spent each year)	15%	$19.62
SFSF	$426.77	$260.05	60%	$156.04
TOTAL	**$688.38**	**$390.87**	**44.9%**	**$175.67**

*For the purposes of this cost benefit analysis, we assume the same total dollars are spent on teachers' salaries in both FY 2009 and FY 2010, despite an overall decline in SFSF ARRA funds in FY 2010 relative to FY 2009.

We investigated the current number of teachers and students in CPS in 2009 to estimate the impact that not receiving ARRA funds would have had on class size. In 2009, CPS had 409,279 students and 21,320 teachers, for an average ratio of 19.2 teachers for every student (Chicago Public Schools 2010). Based on salary and benefits data, we then estimate that the average annual salary of a CPS teacher is $75,000 and the annual benefits package is $25,000, for a total cost of $100,000 per teacher (Chicago Public Schools). However since teachers are laid off based on seniority (Illinois General Assembly), and as a result teachers with lower than average salaries must be dismissed first, we decided to evaluate three different cost scenarios. We then calculated how many teachers CPS would have laid off had they not received ARRA funds by dividing the cost of a teacher in each scenario into the $175.67 million in ARRA funds used for teachers' salaries.

Without ARRA funds the total number of CPS teachers would have increased the student-teacher ratio as shown in the following table:

Table 2. Effect of ARRA Funds on Student-Teacher Ratio

	Scenario 1	**Scenario 2**	**Scenario 3**
Annual salary of a CPS teacher	$75,000[1]	$60,000	$45,000
Benefits	$25,000[2]	$20,000	$15,000
Total	$100,000	$80,000	$60,000
ARRA funds	$175,670,000	$175,670,000	$175,670,000
# teachers funded	1,757	2,196	2,928
# of teachers in 2009 w/ARRA	21,320	21,320	21,320
# of teachers in 2009 w/o ARRA	19,563	19,124	18,392
# of CPS students	409,279	409,279	409,279
# students per teacher w/ARRA	19.20	19.20	19.20
# students per teacher w/o ARRA	20.92	21.40	22.25
Increase in class size	8.98%	11.48%	15.92%

The evidence of impact of class size on achievement is not conclusive, with some researchers purporting that class size differences have no influence on students' educational achievement or other long-term outcomes[3] and some purporting it does.[4] [5]Given this, we decided to look at a range of potential outcomes, with Hoxby's (2000) research as the "floor" estimate, Chetty et al's (2010) Project STAR research as a medium estimate and Krueger (2007) as the "ceiling" estimate.

Table 3. How does class size affect student outcomes?

No Effect	Medium Effect	High Effect
$0 (Caroline Hoxby)	A 33% decrease in class size is associated with a $9,460 income gain (PV) (2011 Chetty et al, Project STAR)	A 31.8% decrease in class size is associated with a $20,937 income gain (PV) (2002 Alan Krueger, Project STAR)

One important point to consider is that prior research in the field has investigated the impact of *decreasing* class size, whereas our intention is to understand the impact of *preventing an increase* in class size. Despite this difference, for our purposes, we assumed that the impact would be the same.

We then estimated income gains per student for all our cost scenarios and impact levels. To do so we first estimated earnings for all students given the impact found in the studies used. Since Project STAR research was based on three years of reduced class size and our analysis of ARRA only on two and assuming that each year of reduced class size has an equal impact on students' lifetime earnings we then adjusted those earnings to reflect the actual timeframe (2/3). Finally since class size could have varied without ARRA funds at different levels than those in

[3] (Hoxby, 2000)
[4] (Chetty, R, et al, 2010)
[5] (Krueger, 2002)

the studies chosen, we adjusted earnings to reflect the real class size change. The estimate found reflected the total benefits of Title I and SFSF funds dedicated to teacher's salaries; when divided by the total number of CPS student we got the income gain per student due to ARRA.

Finally, we performed a Cost Benefit Analysis of the program, using as cost the total amount of funds allocated by ARRA to Tile I and SFSF and the estimated benefits from our analysis.

4. Cost-Benefit Analysis Results

Table 4. Income Gain per Student

Income gain per student	Scenario 1	Scenario 2	Scenario 3
No effect	$0.00	$0.00	$0.00
Medium effect	$1,716.18	$2,193.96	$3,042.49
High effect	$3,759.87	$4,806.60	$6,665.60

As stated in Table 2, Scenarios 1, 2 and 3 represent class size increase prevented given our three salary levels. Scenario 1 explores income gains per student using a prevented a class size increase of 8.98%, Scenario 2 of 11.48% and Scenario 3 of 15.92%. No, Medium and High effect are based on the findings of Hoxby (2000), Chetty et al. (2010) and Krueger (2002) as stated in Table 3. We estimated that income gains per student range from $0 to $6,666 depending on amount of class increase prevented.

Table 5. Net Benefits and Benefit-Cost Ratio

CBA Scenario 1 (8.98%)				
Estimate	Cost (Millions)	Benefit (Millions)	Net Benefits (Millions)	Benefit-Cost Ratio
No effect	$688.38	$0.00	($688.38)	0
Medium	$688.38	$702.40	$14.02	1.020
High	$688.38	$1,538.83	$850.45	2.235

CBA Scenario 2 (11.48%)				
Estimate	Cost (Millions)	Benefit (Millions)	Net Benefits (Millions)	Benefit-Cost Ratio
No effect	$688.38	$0.00	($688.38)	0
Medium	$688.38	$897.94	$209.56	1.304
High	$688.38	$1,967.24	$1,278.86	2.858

CBA Scenario 3 (15.92%)				
Estimate	Cost (Millions)	Benefit (Millions)	Net Benefits (Millions)	Benefit-Cost Ratio
No effect	$688.38	$0.00	($688.38)	0
Medium	$688.38	$1,245.23	$556.85	1.809
High	$688.38	$2,728.09	$2,039.71	3.963

Net Benefits range from a loss of $688.4 million, if we believe that Class size has no impact on student achievement and future wages, as Hoxby (2000) proposes, to a gain of $2.03 billion for a scenario that assumes a higher impact of class size on achievement. It is important to note that even medium impacts have significant Net Benefits.

Early Head Start & Head Start

2. Literature Review - Early Childhood Education

Over the past several decades, the fields of developmental psychology, demography, sociology, economics, and neurobiology have produced a significant amount of research on the importance of positive, stimulating early experiences and environments for the long-term cognitive and social development and mental health of children.

Recently, neuroscience researchers have discovered “sensitive periods” early in human’s lives when the brain’s circuitry demonstrates the most malleability in response to experiences (Knudsen et al 2006). As a result, we now have evidence that early experiences play a more significant role in shaping children’s temperament, social development, perceptual and cognitive abilities – the general foundation for future productivity – than comparable experiences later in life (Knudsen et al 2006). Social and emotional difficulties that onset in the first five years of life

have been linked to negative effects on school achievement and peer relationships in later childhood (Breitenstein et al 2007). Other studies show that children who attend preschool are more likely than their counterparts to perform favorably in the early elementary grades and, ultimately, to achieve more desirable outcomes at age 19 (Berrueta-Clement et al 1984). A study of the Chicago Child-Parent Centers found evidence that the program: 1) decreased expenditures on school and remedial services, criminal justice system services for youth and adult crime; 2) reduced costs of child care, child welfare services, and college tuition; and 3) increased lifetime earnings. (Reynolds et al 2002)

However, many low-income families lack the necessary resources to invest money or quality time in their children. And many of these families are plagued by other stressors (e.g., poor neighborhood safety, unstable employment, substance or domestic abuse,), or are vulnerable in other ways (e.g., single, teen, mentally ill and/or developmentally-delayed parents), that may reduce the priority that these parents place on their child's early learning (DeLuca and Rosenblatt, forthcoming). For these at-risk families, early childcare programs are essential in enhancing their children's intelligence, language skills, and school readiness (Ramey & Ramey 2004).

Two-generation programs have been found to have the potential to maximize the benefits of early intervention programs by providing supports to low-income parents while concurrently addressing the developmental needs of their children. Two of the largest and most prominent two-generation programs are administered by the U.S. Department of Health and Human Services: Head Start and Early Head Start. While program providers have a great deal of discretion in the development of their program models, all are required to provide "high-quality, comprehensive child development services, delivered through home visits, child care, case management, parenting education, health care and referrals and family support." (Love et al 2005). In 2009, these programs served over 900,000 economically disadvantaged children and families, at an average cost of $7,600 per child (US Department of Health and Human Services 2010b).

The Head Start program was created in 1965, and focuses on school readiness by "enhancing the social and cognitive development of children through the provision of educational, health, nutritional, social and other services to enrolled children and families" (US Department of Health and Human Services 2010a). The program strives to promote parents' engagement in their children's learning and aid them in making progress toward their own goals.

Studies have found continued benefits from Head Start participation on children participating, including improved test scores, less grade repetition, and lower special education placement rates (Ramey & Ramey 2004). Others have found evidence that Head Start reduces childhood obesity. However, the average demonstrated effects of participation on children's achievement and school progress are smaller than those yielded by participation in the "model" preschool programs (like Abecedarian and the Perry Preschool Project) that informed Head Start's creation (Barnett 2002). This result is not surprising given Head Start's much lower per child funding relative to the model programs, its wide variety of models and approaches, and the

much larger population it serves. A 2010 study by the Department of Health and Human Services (Westat 2010) reports that the quality of Head Start centers is variable, with no centers rated as "poor," only a few centers rated as "excellent", and the remainder being of a middling quality level ("Understanding the Head Start Impact Study" 2010). Additionally, some studies on the Head Start preschool program suggest that gains made in low-income children's cognitive ability and school achievement begin to disappear after a few years if additional supports are not continued after kindergarten entry (Lee and Loeb 1995).

It is difficult to quantify how cognitive and noncognitive skills of young children translate into long-term life outcomes. Ludwig and Phillips (2008) assess the body of research on this topic, and come to the conclusion that the best available evidence suggests that Head Start does produce long-term benefits that outweigh its costs. They look at work by Garces, Thomas, and Currie who attempted to remove self-selection bias and control for any other unmeasured family attributes that could confound a comparison of Head Start participants to non-participants, by comparing outcomes for program participants relative to siblings that did not participate. Garces et al found that Head Start attendance was associated with significant improvements in educational outcomes for whites, and reduced reported criminal activity among African-Americans (Ludwig and Phillips 2008)

Ludwig and Phillips (2008) also analyze the 2010 Department of Health and Human Services Head Start National Impact Study by Westat. Their analysis finds that all cognitive skills effect estimates point in the right direction (focusing on treatment on the treated) although they are not statistically significant. Ludwig and Phillips claim this is likely due to measurement error as a result of poor reliability of assessment criterion (particularly for noncognitive abilities). When evaluating pooled estimates of outcomes for three and four year olds, they do find statistically significant cognitive outcomes.

The Westat study (Westat 2010) is arguably the most rigorous evaluation of the Head Start program to date. This report to HHS assessed differences in cognitive development, social-emotional development, and health status and services for children participating in Head Start (at age three or at age four) relative to very similar children (a control group) who did not participate in Head Start. It also investigated parenting practices and the quality of the Head Start programs themselves. Compared to the control group, the study found that children who attended Head Start programs had higher-quality early care and education environments, including teacher qualification, classroom literacy and math instructional activities, teacher-child ratios, the nature of teacher-child interactions, and others. At the end of the Head Start year, both the three- and four-year-old Head Start cohorts demonstrated better literacy and language abilities than their counterparts, and were more likely to have received dental care. Three-year-olds were also found to have stronger pre-writing and more advanced math skills than their control group at the end of the Head Start year, and also showed less hyperactive and problem behavior. Parenting practices and parent-child relationships were also healthier for the three-year-old cohort compared to their counterparts.

However, the Westat Head Start Impact Study (2010) found that most Head Start benefits had disappeared by the end of first grade. The few differences that remained at the end of 1st grade for the four-year old cohort included increased receipt of health insurance, less withdrawn behavior, and better receptive vocabulary. The three-year old cohort maintained benefits in oral comprehension, parenting practices and social-emotional development. Thus, one key takeaway from this research is that, as purported by neurobiological and economic research, earlier childhood interventions appear to be more effective than later ones. It also indicates that changing parenting practices sooner may result in improvements in children's behavior and longer-term outcomes (as behavior is tied to long-term academic success).

Several issues with Westat's research methodology may have led to underestimation of the true effects of Head Start. First, 60% of the children not participating in Head Start participated in non-parental childcare or early education programs. In fact, the Head Start non-participants actually spent more hours per week in non-parental care, on average, than the Head Start participants did. Additionally, about 15 percent of the control group children did end up receiving Head Start services, while not all children selected to enroll in Head Start did so, making it even less likely that significant differences between the control group and the Head Start group would arise. Thus, the fact that any positive outcomes were found for Head Start participants relative to non-participants is impressive. Also, the study did not assess the impact of variation in program quality on program outcomes. The researchers found that 70 percent of Head Start programs were rated as having a "good" or "better" quality environment and only 60 percent of the programs provided an emphasis on language, literacy, and math activities. Finally, the social-emotional and health outcomes were not robustly measured, as they were based on parent and teacher self-reports, and hence were subjective (Westat 2010).

Another major concern posed by researchers is that the long-term benefits of Head Start can be identified only for those children who participated in its first few decades of operation, and studies of long-term benefits may not be relevant if effects of Head Start may be changing over time (more preschool options now than previously). Given these caveats, Ludwig and Phillips postulate that Head Start might pass a cost-benefit test if the short-term effects on achievement test scores were as small as 0.1-0.2 standard deviations (assuming current average Head Start costs of around $9,000 per child) (Ludwig and Phillips 2008) and that its benefit-cost ratio could be comparable to those in the model program.

The Early Head Start program was established much more recently, in 1995. Early Head Start (EHS) endeavors to provide high-quality child and family development services to low-income pregnant women and families with children ages three and under. The program promotes healthy prenatal behavior and family functioning to enhance the development of infants and toddlers ("About the Office of Head Start" 2010). EHS allows each community to design the program to best meet the needs of its low-income families.

Little longitudinal research has been done on the Early Head Start program to date. The research available shows that EHS programs that provide a mix of in-home and center-based services produced more significant impacts on a wide range of child and parent incomes,

including: increased children's higher cognitive and language function, which may reduce likelihood of needing remedial services upon school entry; reduced early aggressive behavior in children, which lessens the risk of later behavior problems and difficulty in school achievement; and improved home environments, which support children's learning and development when children are not in child care (Love et al 2005).

3. Cost-Benefit Analysis Methodology

3.1. Early Head Start & Head Start - Early Childhood Education

We performed a basic Cost Benefit analysis of funds allocated to Head Start and Early Head Start expansion. We decided to focus only on those funds because they could be linked to a specific amount of students to be served.

We take as cost the funds awarded by ARRA to the expansion of services. According to the City of Chicago, this amounts to $7.8 million. In our analysis we will not include the additional cost to the government of providing schooling to those students who would have dropped out had they not been in the program.

To estimate benefits we reviewed the literature and found impacts (in percentages) in Treatment versus Control groups due to attending other early childhood programs that have served as models for Head Start and Early Head Start. We acknowledge that model programs vary in size, scope and curriculum so the results of Head Start will not match the exact results of these programs but they can give a general idea of a ceiling impacts might have in the long run. Evidence has shown that early childhood education does have an impact on students' outcomes, so we will assume there is not a No Impact scenario.

The Expansion had a goal of serving 590 additional children in the City of Chicago. To estimate the impacts on these children based on the literature findings we took impact measures from both HighScope/ Perry Preschool and the Abecedarian model and multiplied them by the number of additional children the expansion will serve. We only took impact measures of outcomes that had been measured in both programs. Additional measures not included will only improve the amount of benefits.

Table 1. Impact Measures

Outcomes	**Abecedarian[1]**		**High Scope/ Perry[2]**	
	Dif T v C	**# participants***	**Dif T v C**	**# participants***
Special Education	-23%	-136	-13%	-77
Retention	-24%	-142	-5%	-30
High school grad	16%	94	20%	118
Arrested as juvenile	0%	0	-9%	-53
Smoker	-16%	-94	-11%	-65

*Based on 590 new children served

Table 2. Assumptions

Assumptions	
Kids served EHS	300
Kids served HS	290
Total served by expansion	590
Discount rate (real)	3.20%
Av annual Full time day care 3 year olds	$6,801
Av annual Full time day care 4 year olds	$6,291
Cost of smoking lifetime women	$120,386
Cost of smoking lifetime men	$249,858
Cost of smoking lifetime average	$185,122
Median annual earnings HS grad	$29,893
Median annual earnings HS dropout	$23,416
Difference in earnings	$6,477
Years economically active from 18 to 67	49

Note: Dollar amounts in constant 2009 dollars adjusted when needed using the CPI Inflation Calculator provided by the Bureau of Labor Statistics.

To estimate the present value of additional earnings due to an increase in high school graduates we estimated the present value of a deferred annuity based on the difference in earnings of High School Graduates versus those who did not complete High School (U.S. Department of Education, National Center for Education Statistics (NCES). 2010). The Annuity would start when children turned 18 and continue until they retired at 67. For simplicity of calculation we assumed that the additional income per year for being a High School graduate would be the same each year and that all additional students who graduated lived and worked until retirement age. To get the present value of the annuity at age 3 we used a real discount rate of 3.2%. We did not include additional earning of those who graduated high school and then went on to graduate from college nor do we include the additional tax dollars the government will receive due to this increase in earnings.

To estimate health benefits we used the cost reduction due to a decrease in smokers for participants in both programs. To estimate the value of a decrease in smokers due to early childhood education we multiplied the decrease in smokers by the present value of the cost of smoking (private and social cost). Based on findings by the Sloan et al 2004 study “The Costs of Smoking” we estimated the average lifetime cost for men and women as $194,069 per smoker. We do not include in our analysis any other health benefit that might come from these programs.

We also estimated as a benefit cost saving for early childhood education for parents of the students chosen. If Head Start had not been available they would have had to pay for these services themselves. The cost savings increased money available to spend on other items. We estimated that parents of 3 year olds chosen would have to pay for 2 years of preschool and

parents of 4 year olds for only 1 year. Cost of preschool was estimated using Child Care costs in the State of Illinois as presented by the National Association of Child Care Resource & Referral Agencies (2011). Average annual full time day care for 4 year olds was $6,290 and average annual full time day care for 3 year olds was $6,801. We assume that these cost were the same in 2009 and 2010.

We do not take into account in our analysis benefits from crime reduction due to decrease in juvenile and adult arrests and benefits from a decrease in welfare use. We also do not take into account other benefits attributed to early childhood education such as a reduction in special education and grade retention.

4. Cost Benefit Analysis Results

Table 3. Head Start Cost Benefit Analysis Results

	Scenario 1 (Abecedarian)	**Scenario 2 (Perry Preschool)**
Costs		
ARRA Funds Awarded for Expansion	$7,802,335	$7,802,335
Benefits		
Pre k/ k costs savings	$6,030,050	$6,030,050
Health	$17,475,509	$12,014,413
Increase in Earnings for Additional HS Graduates	$9,701,473	$12,126,842
Total Benefits	$33,207,033	$30,171,304
Net Benefits	**$25,404,698**	**$22,368,969**
B-C ratio	**4.26**	**3.87**

We estimate that funds allocated to Head/ Start and Early Head Start expansion could produce Net Benefits that range from $22.37 million to $25.4 million, with Benefit Cost ratios around 3.8 - 4.2

Homeless Prevention and Rapid Re-Housing

2. Literature Review

Common impact measures were developed to evaluate both the Homelessness and Rapid ReHousing program, and the Community Service Block Grants aimed at mitigating problems associated with homelessness and mental health. The American Recovery and Reinvestment Act (ARRA) funds allocated to housing relocation will decrease the costs associated with case management, and increase efficiency in processing and placing homeless into subsidized housing. A review of the literature shows a high correlation between homelessness, substance abuse, and homelessness.

2.1. A New Approach to Homelessness

The passage of ARRA redirected the national approach to addressing homelessness by focusing on prevention of homelessness rather than on those individuals and families who are already homeless. The new Homelessness Prevention and Rapid ReHousing Program (HPRP) provides support to at-risk individuals and also attempts to move homeless households into permanent living situations. The HPRP does not support shelters and other traditional services. While studies of prevention programs in European countries have demonstrated positive outcomes for participants, much more research will be necessary in order to understand the how effective these programs will be in the U.S. (Culhane et al 2010). In their paper, "A Prevention-Centered Approach to Homelessness Assistance: A Paradigm Shift?", Dennis Culhane, Stephen Metraux, and Thomas Byrne cite the most important goals for homelessness programs as 1) providing affordable and accessible housing to all; 2) eradicating poverty; and 3) preventing substance abuse. These broad ideas can be focused into specific impact measures to be measured in a cost-benefit analysis. Two main measures should be the focus: efficiency and effectiveness (Bush 2005). A successful homeless prevention program will reduce overall homelessness in the target area, reduce costs associated with public health, and a decrease substance abuse rates.

2.2. First-time Homelessness versus Repeat Homelessness

Specifically insightful to the analysis of the value of Homeless Prevention funds was the paper distributed by the U.S. Office of Housing and Urban Development titled, "Costs Associated with First-Time Homelessness for Families and Individuals", which, using research from seven cities, attempts to estimate the cost of first-time homelessness, a new focus on the area of homelessness studies. The HUD report measures costs associated with first-time homeless families and individuals incurred by homeless and mainstream service delivery systems in six communities. Unaccompanied individuals were studied in Des Moines, Iowa; Houston, Texas; and Jacksonville, Florida. Families were studied in Houston, Texas; Kalamazoo, Michigan; Upstate South Carolina; and Washington, DC.

The first-time homeless individuals in the communities studied were predominantly male (73 to 81 percent) and had an average age of 39 to 41 years at program entry. African-Americans are over-represented among first-time homeless individuals in comparison to the general population of individuals in poverty. The first-time homeless families in the study primarily had only one adult member (80 to 89 percent), were comprised of female adults accompanied by children (82 to 90 percent), and had on average 3 to 3.5 members. On average, adults were 30 to 32 years old when they first used a homeless program, and 41 to 50 percent of the children were 6 years old or younger.[6] The majority of individuals studied (55% – 67%) were only homeless for a very short period of time, ranging from one to three weeks, and their use of emergency

[6] "City of Chicago :: Basic Needs (Health & Human Services)." *City of Chicago*. Web. 28 March 2011. <http://www.cityofchicago.org/city/en/progs/recovery_reinvest/education3.html>

shelters represented the best use of funds – given that these shelters are very low cost for individuals.

The findings from the study provide a broad-base for understanding of homelessness and its associated costs; it presents ideas about opportunities for cost savings and lays out the groundwork for communities to successfully deal with their homeless, and at-risk families. The study identified the various costs associated with first-time homelessness and how they vary by region and user; emergency shelters are the lowest-cost option for individual adults, but the highest cost option for families, as they frequently require their own rooms or special accommodations. The highest cost savings were identified for those individuals and families that use these services for longer terms, which quickly deplete funds and reduce the opportunity for turnover or helping many individuals (Abt Associates Inc, et al 2010). Lastly, further research areas are identified such as evaluations of program size or structure as related to cost savings, using characteristics to identify at-risk individuals before they become homeless and the need for further research involving the mainstream costs associated with homeless individuals.

Determining the value of preventing homelessness presents a challenge in that there is no easy way to measure the cost of an individual or family becoming homeless. Estimates vary from $0 to hundreds of thousands of dollars, depending upon the duration of homelessness, the medical and mental condition of the individual, where they are located, and many other factors.

2.3. Homelessness and Mental Health

Homelessness and mental health problems are highly correlated (Gelberg 1988). A 2000 study on service interventions for mentally ill homeless people (outreach, case management, and housing placement) showed positive effects across measures of health and housing outcomes, but major additional costs are also associated with such programs (Rosenheck 2000). A 2003 cost-effectiveness study performed a random control trial experiment on 96 study participants in 1991 to 1993. The treatment group was assigned to a critical time intervention. The study produced significant positive results for the treatment group: they received services at a cheaper rate than the control group for acute care services, outpatient services, housing and shelter services, criminal justice services, and they spent less homeless nights (Jones et al 2003).

A second 2003 study focused specifically on supported housing that integrated clinical services for homeless veterans with mental illness and substance abuse issues. In 1992, 460 participants were assigned to one of three groups 1) a voucher and intensive case management program, 2) a case management only program, and 3) a standard VA care program. Outcomes measured were days housed vs. days homeless, mental health status, community adjustment, and costs. Findings showed that veterans receiving vouchers and intensive case management had 16 percent more days housed than the case management only group, and 25 percent more days housed than the standard care group. Additionally, the first group was served more cost effectively, but it did not show better outcomes in measures of substance abuse, mental health or community adjustment (Rosenheck 2003).

3. Cost Benefit Analysis Methodology

3.1. Homeless Prevention in the United States

In order to determine the impact of the ARRA funding for homeless prevention, we worked with the Emergency Fund to collect data on the funds they have distributed thus far to participants in their homeless prevention program. This data would be used to calculate the average cost of homeless prevention in Chicago. To contrast what was spent with the estimated cost of first-time homelessness, we worked primarily with data from HUD's report, "Costs Associated with First-Time Homelessness for Families and Individuals". The key impact measure then was the direct-savings of preventing homelessness; other non-direct costs are noted, but not included in the final analysis. From this study we used their low and high estimates of the direct cost of first-time homelessness and calculated an overall average cost of $2,202 for an individual and $12,935 for a family with children (see table 1). To conduct a baseline analysis we decided to use the HUD report noted above to find an average cost of first-time homelessness.

Table 1: Estimated cost of first-time homelessness from HUD report (2010)

	Estimated cost of first-time homelessness		
	Low Cost Estimate	High Cost Estimate	Average Cost Estimate
Individual	$1,831	$2,572	$2,202
Family	$3,548	$22,322	$12,935

Note: Average calculated using data given from HUD report page ES-7

These cost estimates are of the direct cost of first-time homelessness and include only services that are targeted to and used solely by those who become homeless such as shelters, emergency shelters, street outreach programs, transitional housing, and other services created only for the consumption of homeless individuals and families.

The indirect costs of homelessness are all mainstream costs that are not exclusive to homelessness which cannot be easily separated from the costs of non-homeless users. Mainstream costs include items such as medical expenses, often in the form of emergency room visits, use of law enforcement and the criminal justice system, mental health treatment, drug rehabilitation, and other such services. Various studies of the mainstream costs of homelessness have estimated the cost per individual or family much higher than just the first-time costs we consider further below, these increased costs that could impact the true estimate of first-time homelessness.

A Massachusetts study found that the average medical cost of a homeless person was $26,124/year.[7] The New England Journal of Medicine found that Homeless people spent an average of four days longer per hospital visit than comparable non-homeless people, costing approximately $2,414 more per hospitalization.[8] And a two-year survey of homeless individuals conducted by the University of Texas found that each person cost the taxpayers $14,480 per year, primarily for overnight jail.[9] While these numbers do not directly translate to Chicago, or to all homeless, they highlight the significant costs of homeless to individuals and society as a whole and illustrate that the cost of first-time homelessness can be much higher and frequently depend on who becomes homeless.

3.2. Homeless Prevention in Chicago

Using the Emergency Fund data on the distribution of ARRA funds from January 2010 to March 2011, we were able to calculate the average amount of money distributed to prevent homelessness in various situations (see table 2). The total amount distributed for homeless prevention was a little over $5 million ($5,076,312), and a total of 713 families (adults with at least one child) and 889 adults were helped and kept in their homes. In our analysis we assume the counterfactual is that if these funds were not distributed, these individuals and families would become homeless, incurring costs on the system.

Table 2: Cost of Homeless prevention in Chicago based on distribution of ARRA funds

	Individual Adult	**Family with children**
Average assistance given	$1,295	$3,653
Individuals or families helped	889	713

Source: Authors' calculations based on data provided by the Emergency Fund for homelessness prevention funds distributed from 1/10 – 3/11

4. Homeless Prevention Cost-Benefit Analysis Results

The results of the analysis on funding for Homeless Prevention show that investing in homeless prevention is economically sound. In the analysis, which used the average cost of homeless prevention from the data from the Emergency Fund and the average cost of homelessness based on the HUD report, we found that preventing homelessness always led to cost savings. Through the emergency fund's prevention of homelessness we estimate a cost savings of about 7.5 million dollars (or $7.1 million in 2009 dollars).

[7] MA homelessness study
[8] New England Journal of Medicine study
[9] UTexas study

These savings were derived using the Emergency fund data indicating they had assisted 889 individuals and 713 families with children, costing an average of $1,295 and $3,653 respectively. We then used the average cost of homelessness from the HUD report and subtracted the average cost in Chicago, which always lead to cost savings, with a savings of $907 per individual and $9,282 per family, again, assuming that the counterfactual is that the individual/family would have become homeless had it not been by the ARRA-funded support from the Emergency Fund. To find the overall impact of the funding we multiplied the savings per unit by the total units (either individuals or families) that were prevented from becoming homeless and found savings/ prevented spending of approximately $7.5 million dollars ($7.1 mil. in 2009 dollars) about $800 thousand for individuals and 6 million for families. This is about $2.4 million in net benefits ($2.24 mil. in 2009 dollars). Extrapolating the preceding data for the number of potentially homeless individuals and families served leads to a savings of approximately $7.5 million dollars or a return of $1.46 ($1.39 in 2009 dollars) for every $1.00 spent for prevention. See table 3 for calculations in 2011 dollars, relevant outcomes converted to 2009 dollars in preceding paragraph.

Table 3: Savings realized by preventing homelessness in Chicago

	Individual Adult	**Family with children**
Average cost of first-time homelessness	$2,202	$12,935
Average assistance given	$1,295	$3,653
Average savings (cost - assistance)	$907	$9,282
Individuals or families helped	889	713
Savings to date (Average savings x number helped)	$805,878.50	$6,618,066.00

Note: Calculations completed by author, using data from tables 1 and 2.

In these calculations we opted to focus on averages rather than breaking out the data to individuals or families receiving one-time assistance versus receiving assistance more than once, as we initially thought would be valuable, because the program is not yet complete and funds are still being distributed. Dividing the data in such a manner prior to the completion of the program would skew the cost of one-time assistance, likely higher, as many of the individuals who are currently marked as ‘one-time’ users, may need assistance again before the funds are spent, especially since the data used ends in March 2011.

5. Conclusion and Recommendations

5.1. Title I and SFSF funds

Based on our analysis of the results we find that it was a good idea to invest Title I and SFSF funds to prevent teacher layoffs and class increases. Because of the rules and regulations in place regarding who gets laid off the impact of the possible layoffs would have been on the high side. Though evidence on the impacts of class size has been mixed we believe keeping classes small does have a positive impact on achievement. If we not only kept the classes small, but also retained the best teachers, impact could be even greater. Because the decision on who gets laid off is based on seniority and not on performance one area to explore in the future could be introducing performance results into this decision.

Benefits are not only private, but society and the government can experience some of them as well. By keeping classes small there is an income gain to students, which then translates into higher taxes paid to the government, who in turn invests that additional revenue in programs of benefit to society.

5.2. Early Head Start/ Head Start

Based on our analysis of the Head Start Expansion we think it is a good idea to continue funding Head Start. The problem with early education program is that benefits are accrued throughout the lifetime of the student, with most of them coming long after they finish the program so it is difficult to justify the cost in the short term, especially since cognitive gains in students have proven to fade out over time. However non-cognitive gains have proven to have an even higher impact, with students attending these programs showing, among other benefits, lower crime rates and better health outcomes than their peers. These impacts bring clear benefits to society and the government.

For the Head Start programs to have the maximum results that resemble those of the model programs, some changes are needed. What these are should be explored further in future research.

5.3. Conclusions and Recommendations

Based on our findings, investing in homeless prevention is a good idea and the city should continue to fund, or seek funds to keep this program in action after ARRA funds are depleted. Further, we believe our estimates of the benefits of preventing homelessness may be underestimated and that the benefits realized by the city are far greater. While the direct costs of these outcomes show it may only cost society a few thousand dollars for an individual or family to be homeless, these costs do not include the myriad of non-direct costs that homelessness creates. As noted earlier various studies have found the costs of homelessness can be far greater

than the direct costs in the HUD study and our analysis; 26,124 per year in medical costs, $14,480 per year in overnight jail and an extra $2,414 per hospital stay are just some of the potential increased costs.

Beyond these costs are the social costs of homelessness that cannot be measured, what is the lifetime impact of becoming homeless? How does homelessness impact children? And what are the costs to society of allowing people, just like us, to become homeless? While these questions cannot be directly analyzed, it is worth considering that the benefits from preventing homelessness far outweigh the thousand dollars per person and few thousand per family.

Chapter 2. Workforce Development

1. Introduction

1.1. Overview of ARRA Workforce Investment Act Funding

The eleven-county metropolitan Chicago region received an allocation of approximately $90.4 million for Workforce Investment Act (WIA) Adult, Dislocated, and Youth programs through the American Recovery and Reinvestment Act (ARRA).[10] Cook County's allocation of approximately $64.1 million is roughly 68% of total ARRA funds allotted to the metropolitan Chicago region for workforce development programs and approximately 39% of Illinois' allocation of ARRA funds for workforce development purposes (Workforce Development Boards of Metropolitan Chicago, 2010). Of the $64.1 million allocated to Cook County, WIA Dislocated Worker programs received an estimated $26.7 million, WIA Youth programs received $25.1 million, and WIA Adult programs received $12.3 million (Workforce Development Boards of Metropolitan Chicago, 2010). Between February, 2009, and June, 2011, we calculate that an estimated 5194 Cook County residents participated in WIA Dislocated Worker programs, 3433 residents participated in WIA Adult programs, and 10,338 residents participated in WIA Youth Programs (Metropolitan Workforce Boards of Chicago, 2010). We return to how we calculated these estimates in the cost-benefit analysis section below.

In order to convey the nature of WIA services, it is useful to briefly describe the target populations of each constituent program. Passed by Congress in 1998, WIA programs replaced the Job Training Partnership Act to create a "comprehensive" set of integrated services, ranging from training services to career planning (Heinrich, Mueser, and Troske, 2008). WIA Dislocated Worker programs primarily assist workers who have been terminated and have difficulty finding employment. Such workers may include individuals who have lost employment due to "permanent" plant closures and are unlikely to find employment in their previous occupation (Illinois Department of Commerce and Economic Opportunity, 2007). WIA Adult programs serve economically disadvantaged adults with weak labor market attachments with entry or reentry into the job market (Workforce Development Boards of Metropolitan Chicago, 2010). Finally, WIA Youth programs assist primarily low-income eligible youth, ages 14 – 21, who encounter barriers to employment. In the metropolitan Chicago region, WIA Youth services primarily provided eligible youth with employment opportunities during the summer of 2009 (Workforce Boards of Metropolitan Chicago, 2009).

[10] The 2010 report by the Workforce Boards of Metropolitan Chicago includes allocations for the following counties: Cook, Lake, McHenry, Kane, DeKalb, Kendall, DuPage, Will, Grundy, Livingston, and Kankakee. For a list of allocations by county, see: Workforce Boards of Metropolitan Chicago. 2010. Status Report: Use of American Recovery and Reinvestment Act Funds Expanding the Workforce Investment Act Program. Workforce Indicator Report 09. <http://www.workforceboards metrochicago.org/publications/>.

1.2. ARRA-Funded Services and Programs

In the metropolitan Chicago region, ARRA funds supported the following kinds of services. For WIA Dislocated Workers, 60% of enrollees received classroom training, ranging from occupational classroom training to training in green jobs. Private sector training accounted for less than 1% of training services, and 76% of enrollees received career planning assistance (Workforce Boards of Metropolitan Chicago, 2010). With respect to WIA Adult programs, approximately 44% of enrollees received classroom training, and 81% received career planning (Workforce Boards of Metropolitan Chicago, 2010). Finally, for WIA Youth programs, 98% gained paid work experience through ARRA funding, and 67% received some job search and skills training (Workforce Boards of Metropolitan Chicago, 2010). These numbers make clear that some enrollees may receive overlapping services and may experience different intensities of service provision, which is consistent with the literature on workforce development that we discuss below.

In terms of specific workforce development programs, one of the largest recipients of ARRA funds in Cook County was the Workforce Board of Northern Cook County.[11] The Workforce Board of Northern Cook County received approximately $3.5 million for WIA Dislocated Worker, Adult, and Youth services. In terms of training and job placement services, the Workforce Board of Northern Cook County focuses on training and job placement strategies in the following sectors: health care, transportation, warehousing and distribution, technology, and hospitality. Another large recipient of ARRA funds was the Community and Economic Development Association of Cook County (CEDA). CEDA received approximately $2 million dollars in ARRA funds and provides both training services and job search/placement services. With regard to training services, CEDA offers occupational skills training, on-the-job training, job readiness training, and education and literacy services.[12]

The analysis proceeds as follows. In the second section, we review appropriate impact measures through a discussion of relevant studies and evaluate the comparability of WIA participants in the metropolitan Chicago region to participants in these studies. In the third section, we present our methodology and findings for a cost-benefit analysis of Cook County workforce development programs. Finally, in the fourth section, we offer an assessment of our cost-benefit analysis and some considerations for future evaluations of Cook County workforce development programs funded by ARRA.

[11] Obtained from www.recovery.gov.
[12] Obtained from http://www.cedaorg.net/www2/ETS.html

2. Review of Literature, Impact Measures, and Participant Demographics

2.1. Relevant Workforce Investment Act Evaluations

In the realm of workforce development evaluations, experimental designs relying on random assignment tend to be costly and politically controversial (Smith, 2000). In this context, "quasi-experimental" methods using propensity score matching have become a popular method among researchers of workforce development programs (Smith, 2000). Within the array of propensity-score matching techniques, the "nearest neighbor" matching method chooses non-participants that are close to participants on a range of characteristics (Heckman, LaLonde, and Smith, 1999). Currently, this matching approach is popular in terms of workforce development evaluations, particularly when large sets of administrative data are available (Smith, 2000). In our review of the literature, most studies employ the nearest-neighbor matching method or some variation on this approach when random assignment is not possible.

In the first-ever evaluation of WIA programs for the United States Department of Labor, Heinrich, Mueser, and Troske use state-level administrative data to conduct a non-experimental evaluation of WIA Adult and WIA Dislocated Worker programs across twelve states. Their evaluation includes approximately 160,000 WIA participants who entered the program in 2003-2005 and about three million comparison group members (Heinrich, Mueser, and Troske, 2008). Accoring to Heinrich, Mueser, and Troske, they match participants to non-participants based on a range of demographic characteristics, such as type and duration of labor market experience, receipt of public assistance, and geographic location (Heinrich, Mueser, and Troske, 2008).

For this evaluation, the authors use the change in earnings relative to the control group as the key impact measure, and they do not conduct a full cost-benefit analysis for each program. Importantly, they note that participants in both the Adult and Dislocated programs receive a range of services, may receive more than one service, and the intensity of such services varies across participants. In this vein, they indicate that the impacts or change in earnings that they estimate must be viewed as an "average" (Heinrich, Mueser, and Troske, 2008). In general, the evaluation finds stronger, more positive net benefits for participants in the WIA Adult program and more mixed results for participants of the Dislocated Worker program. Overall, the authors speculate that pre-program dip in earnings is more modest for WIA Adult program participants and more "pronounced" for WIA Dislocated Worker participants. Additionally, they indicate that the opportunity costs of program participation for individuals in the Adult programs may be somewhat less than for their counterparts in the Dislocated Worker programs (Heinrich, Mueser, and Troske, 2008). We return to this observation in our cost-benefit analysis and conclusion below.

For both programs, the authors present average impact estimates for quarters 1-5 and quarters 11-16 in order to compare earnings immediately after program participation to those gained a few years afterward. Importantly, the authors include zero earnings within their estimates for all programs. As such, the authors account for changes in wages and whether

participants are employed after program participation. Across the 12 states surveyed and accounting for both genders, 18 of 24 impact estimates for WIA Adult workers are positive and statistically significant with only one impact estimate being negative and statistically significant for quarters 1-5. The range of increased earnings varies from a low of $208 per quarter to over a $1000 (Heinrich, Mueser, and Troske, 2008). For quarters 11-15, the authors find 18 statistically significant estimates with all being positive. The increases in earnings range from a low of $158 to high of over $1400 (Heinrich, Muesker, and Troske, 2008). Overall, the authors report that the average return over all 16 quarters is $500 to $600 for women and about $400 for men (Heinrih, Mueser, and Troske, 2008).

For WIA Dislocated Workers, the results are more mixed. In quarters 1-5, 13 of 24 estimates on changes in earnings are statistically significant. Of these statistically significant estimates, 8 out of the 15 are negative changes in earnings. For WIA Dislocated Workers in the first five quarters, the report shows that changes in earnings range from a low of -$1813 to a high of $888. For quarters 11-16, 17 of the 24 impact estimates are statistically significant and only 3 are negative. These changes in earnings range from a low of -$345 to a high of $1292 (Heinrich, Mueser, and Troske, 2008). Overall, the study finds that WIA Dislocated Workers experience a change in earnings that is $200-300 below the comparison group for quarters 1-5 and an *increase* in earnings for quarters 11-16 that surpass the comparison group by about $400 (Heinrich, Mueser, and Troske, 2008).

In a three-state report of workforce development studies in Indiana, Washington, and Virginia, Hollenbeck reports that all studies use propensity score matching and the nearest-neighbor matching technique (Hollenbeck, 2009). In short, the studies statistically match participants of WIA programs to enrollees in Labor Exchange programs in each state with the latter acting as the control group (Hollenbeck, 200). In contrast to the Heinrich study, Hollenbeck reports outcomes for participants in WIA Youth programs, which is important to our analysis below.

All three state studies use changes in earnings as a key impact measure to evaluate the net benefits of the program. Also, each study uses overall public benefits, including increases in tax revenue and decreases in public supports like unemployment insurance, as impact measures. Accounting for the effect of taxes, earnings impacts are based on after-tax wages and income (Hollenbeck, 2006). As in the Heinrich study, Hollenbeck includes zero earnings in the case of post-program unemployment in all earnings averages (Hollenbeck, 2009).

In conducting cost-benefit analyses for each WIA program, Hollenbeck estimates changes in earnings over the first 10 quarters after program participation and over the lifetime. Over the lifetime, all net benefits tend to be positive when discounted at the 3% level (Hollenbeck, 2009). By contrast, during the first 10 quarters after program participation, Hollenbeck finds greater net benefits for WIA Adult programs. By contrast, he reports more mixed results on net benefits for WIA Dislocated Worker programs and WIA Youth programs (Hollenbeck, 2009). We find Hollenbeck's cost-benefit analyses for WIA programs over the 10 quarters after the program to be more compelling than the lifetime estimates, and we use

Hollenbeck's method and values for opportunity costs, public benefits, and private benefits in our cost-benefit analysis below.

2.2. Demographics for Metropolitan Chicago Program Participants

Overall, the demographic makeup of the metropolitan Chicago ARRA WIA programs is roughly similar to the demographic breakdowns of other WIA programs throughout the country. Table 1 below summarizes the demographics for each WIA category.

Table 1. Workforce Boards of Metropolitan Chicago (2010)

WIA Program	Male	Female	Black	White
Adult	38%	62%	62%	24%
Dislocated	57%	43%	34%	50%
Youth	45%	55%	71%	16%

In comparison, the twelve-state study reports approximately 58% of WIA Adult program participants as female and 44% of participants as black (Heinrich, Mueser, and Troske, 2008). Although the Chicago region is consistent with these findings in that program participants tend to be female, it is clear that the WIA Adult programs in the Chicago region tend to consist more of black participants than is true across the nation. In general, greater representation of blacks in the program may have earnings implications for local programs. Nationally, whites' median personal income earnings are about 20% higher than for blacks (U.S. Census Bureau, 2008). This implies that the earnings impacts for participants of Cook County WIA Adult programs may be lower. We account for this issue by reporting both a high and low estimated net benefit in our cost-benefit analysis below.

With regard to Dislocated Workers, the twelve-state study of WIA programs for the U.S. Department of Labor reports roughly 49% of dislocated worker participants as male and 33% of participants as black (Heinrich, Mueser, and Troske, 2008). In this vein, the demographic makeup of metropolitan Chicago WIA Dislocated Worker program participants is fairly consistent with these more "national" findings in that workers tend to be more represented by whites and more evenly split among genders than the WIA Adult programs.

Finally, in terms of WIA Youth programs, about 99% are classified as low-income with 53% of participants being food stamps recipients (Workforce Boards of Metropolitan Chicago, 2009). Overall, the data suggest that ARRA WIA Youth participants in Cook County are largely low-income, and this is consistent with the eligibility requirements of the program (Workforce Boards of Metropolitan Chicago, 2009). What differs between ARRA WIA Youth programs in

the Chicago region to other evaluated WIA Youth programs is that the Chicago programs have consisted of primarily of paid employment rather than training services.

3. Methodology and Cost-Benefit Analysis

3.1. Methodology

For our cost-benefit analysis, we break down the analysis into two different categories: how we estimated the number of participants for each program and how we derived the costs, benefits and subsequently the net benefits for each program. The 2010 report by the Workforce Boards of Metropolitan Chicago details how much money was spent on each specific program from February 2009 through June 2010, how much was to be allocated by the end of the ARRA funding term, and how many individuals participated in the WIA Adult, Dislocated, and Youth program, respectively. For the estimates of benefits and costs, we obtain our data from the Hollenbeck (2009) and Heinrich, Mueser, and Troske (2008) evaluations that we reference above.

Additionally, the 2010 report details the number of participants and amount of ARRA money spent up until June 2010. At this time of the report, approximately 90% of all funds had been spent for all programs (Workforce Boards of Metropolitan Chicago, 2010). Importantly, the majority of funds for WIA Youth programs were spent in the summer of 2009. Owing to this fact, we extrapolate the amount of participants through the end of the funding period, June 2011, for only the WIA Adult and Dislocated Worker programs, as our counterfactual is that WIA Youth programs were simply not funded beyond that of summer 2009. Given the report provides a detailed breakdown of the money spent as of June 2010 by each of the Chicagoland Counties (Lake, McHenry, Kane, DeKalb, Kendall, DuPage, Cook, Will, Grundy, Livingston, and Kankakee), we are able to isolate the amount of money spent within Cook County specifically for each program.

We use this data to estimate the amount of participants of each WIA program in Cook County and the cost per participant for each program. First, we calculate the per participant cost for the total spent on each program over the metropolitan Chicago region. For the Adult program, $14,297,759 was spent on 3,959 program participants, resulting in a $3,611 cost per participant. For the Dislocated Worker program, $30,631,743 was spent on 5,956 program participants, resulting in a $5,143 cost per participant. Finally, for the Youth program, $31,772,192 was spent on 13,059 participants, resulting in a a $2,432 cost per participant cost (Workforce Boards of Metropolitan Chicago, 2010). With the per participant cost, we use the full allocation of ARRA funds to be spent by June 2011 for each program in the Cook County and divide by the per participant cost. Our calculations show an estimated 3,433 participants in the Adult Disadvantaged program, 5,194 in the Dislocated Workers program, and 10,338 in the Youth program. These costs generally align with what was reported as the direct ‘public’ cost per participant in the research. Our Adult program cost fell within the average of the costs

reported in the literature cited above, while our Youth and Dislocated programs each were close to the higher end of the costs reported.

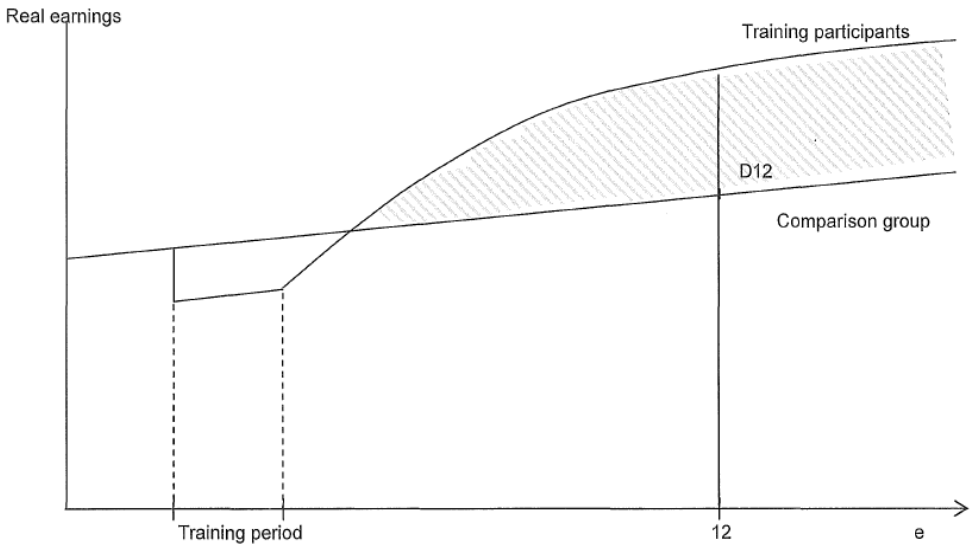
Next, we consider the private costs to the individual. Overall, our research indicates a fairly consistent consideration of an opportunity cost burden on program participants, which is to be considered as the forgone earnings to the individual as a result of program participation (Hollenbeck, 2009). The research considers this to be a one-time cost of forgone earnings a program participant has to bear while enrolled in the program. The participant is matched to a statistically similar individual in the Labor Exchange program (who is earning income) and matched income is considered to be what the program participant is foregoing. As such, this is a one-time cost incurred while only in the program. As an important note, we take a lower and upper bound from all researched costs and benefits in order to provide a range of values. We base our final opportunity costs for each separate program primarily on Hollenbeck's findings: Adult $0 and $1,350, Dislocated Workers $6,440 and $13,640, and for the Youth participants $0 and $495 (Hollenbeck, 2009). Hollenbeck and Huang's Washington state study show that participants in the WIA Adult and Youth programs on average do not demonstrate any forgone earnings while being a part of the WIA program (Hollenbeck and Huang, 2006). As such, we use $0 as a reasonable lower bound. These private costs and private/social benefits are all in terms of 2006 dollars, but we convert the numbers into 2009 dollars for our cost-benefit analysis below.

With the estimated amount of participants in each program, the program cost per participant for each program, and the opportunity cost per participant, we next evaluate the benefits per participant. We report on two different types of benefits: private and public. With regard to the private benefits accruing to participants, we use the impact measure of change in earnings by quarter. As we explain above in our discussion of both the Heinrich, et al., and Hollenbeck studies, the change in earnings is the statistically significant difference in earnings realized by a program participant that is not realized by someone who is statistically matched to the program participant but who does not enroll in the WIA program. With regard to the public benefit, the three-state Hollenbeck study in particular quantifies a benefit to the public in which he computes as increases in tax revenues and decreases in transfer programs, such as unemployment insurance, due to upticks in employment and earnings (Hollenbeck, 2009).

Due to the fact that changes in earnings vary across quarters after program participation, we establish a time horizon for our benefits. One point of general agreement in the research is that in the short term, defined as 1-5 quarters after program exit, increases in earnings will be smaller and any net benefits may be lower or negative. This is due to the fact that the benefits from the program take some time to increase and accumulate to a point where the net benefits start to become unequivocally positive. Although some studies, such as the Heinrich, et al., tend to extrapolate the benefits into 'lifetime' benefits, this seems optimistic. As a result, we follow more closely the comprehensive cost-benefit analysis of Hollenbeck and calculate long-term benefits as 8-12 quarters after program exit (Hollenbeck, 2009). This also appears to be the critical point at which the increases in earnings for the average participant tend to level off, and

there is generally no more increase in benefit to the participant. The figure below from the Hollenbeck study illustrates this point.

Figure 1



Similar to our values for costs, we use a high and low value for both private and public benefits. For the change in earnings over 10 quarters, we determine these average changes in quarterly earnings for each program: $455 and $658 for the WIA Adult program participants, $310 and $1,009 for the Dislocated Worker participants, and finally $0 and $325 for the Youth program participants. Over the accumulation of 10 quarters, we determine the following public benefits per participant: $2,916 and $3,989 for the WIA Adult program participants, $882 and $5,770 for the Dislocated Worker participants, and finally $0 and $1,864 for the Youth participants. Importantly, the Hollenbeck study from which we derived these values indicates some level of statistical significance associated with the change in quarterly earnings between the treatment group and the control group (Hollenbeck, 2009). Finally, it is important to note that private and public benefits are discounted at a rate of 3% (Hollenbeck, 2009).

3.2. Cost-Benefit Analysis

Using the values we report above, we calculate the following net benefits for ARRA WIA programs in Cook County in Table 2 below.

Table 2

	Private Cost per Participant	Public Cost per Participant	Private Benefit per Participant	Public Benefit per Participant	Net Benefit per participant
Disadvantaged Adult Workers: 3433 participants	Low: $0 High: $1,436	$3,611	Low: $484 High: $700	Low: $3,103 High: $4,244	Low: $2,982 High: $7,633
Dislocated Workers: 5194 participants	Low: $6,853 High: $14,515	$5,143	Low: $329 High: $1,073	Low: $938 High $6,140	Low: -$15,430 High: $4,874
Youth Program: 10,338 participants	Low: $0 High: $526	$2,432	Low: $0 High: $345	Low: $0 High: $1,983	Low: -$2,958 High: $3,001

A. Private cost per participant is the forgone earnings of a participant for the duration of the program, which a statistically similar worker received that was not in the program.
B. Public cost per participant is the amount of money allocated to the Cook County and Chicago area for the specific program divided by the number of participants.
C. Private benefit per participant is the difference in earnings between the program participants and a control group of statistically similar non-participants for a duration of 8-12 months after the program.
D. Public benefit per participant is an average of increased tax revenue from the increased wages plus a reduction in transfer benefits, aggregated for 8-12 months after the program.
Net Benefit = (C*10 + D) – (A + B), 10 is used as the average of 8-12 quarters. HIGH calculated using high benefits and low costs, while LOW calculated using Low benefits and high costs. These numbers were derived from (Hollenbeck, 2009) and (Workforce Boards of Metropolitan Chicago, 2010) and are reported/converted into $2009.

For the low net benefits, we multiply the low private benefit by 10 (representing the number of quarters) and then add to it the low public benefit, since the public benefit is already an accumulation of 10 quarters as reported. From this we subtract the public cost and the high private cost. For the high net benefits, we perform a similar calculation, but use the high private and public benefits and the low private cost. Next, we determine the total net benefit of each program by multiplying the net benefit per participant for a program by the estimated number of

participants within that particular program. This results in the following range(s) of net benefits per WIA program:

Table 3

ALL NUMBERS IN MILLIONS OF $s In $2009	Low Net Benefit	High Net Benefit
Dislocated	**-$80.1**	**$25.3**
Youth	**-$30.5**	**$31.0**
Disadvantaged	**$10.2**	**$26.2**
Total	**-$100.4**	**$82.5**

Again, the costs and benefits have been calculated in terms of 2009 dollars, although initially reported in 2006 dollars. Through the cost-benefit analysis, we observe that the only program that potentially guarantees a positive total net benefit is the WIA Disadvantaged Adult worker program, where the total net benefits range between $10.2 and $26.2 million. The Dislocated worker program appears to potentially have the lowest total net benefits, ranging between -$80.1 and $25.3 million, using either our high or low estimates. This appears to be primarily due to the potential high private cost a participant of this program may bear in foregone earnings. Finally, the Youth program almost has an average total net benefit of $0, where the range is from -$30.5 and $31.0 million. We attribute this finding to the lower bound of the private benefits or change in earnings being $0, meaning that the participants may not statistically differentiate their income within the 2.5 years following the program compared to a control group of matched peers. In this vein, even though their opportunity cost is potentially 0, their increase in earnings could be small. However, given that ARRA-funded WIA Youth programs offered paid work experience to 98% of participants, the overall net benefits of the program may be positive.

4. Final Considerations

Given the weaker labor market attachment of WIA Adult workers in general, it is surprising that our results and the other research suggest WIA Adult programs have higher net

benefits on average than WIA dislocated worker programs. It is important to explain the reasons behind these results and why it may be necessary to interpret such findings cautiously. We attribute the relatively lower net benefits for WIA Dislocated workers to a pre-program dip in earnings or "Ashenfelter's dip" (Heckman, LaLonde, and Smith, 1999). As the 2008 report for the Department of Labor evidences, WIA Dislocated Workers display lower average earnings than their comparison groups by about $200 to $300 in quarters 1-5 (Heinrich, Mueser, and Troske, 2008). By quarters 11-16, these same workers tend to display higher earnings relative to comparison groups at a level of about $400 on average (Heinrich, Mueser, and Troske, 2008). By contrast, Adult workers who tend to have less labor market attachment demonstrate almost unequivocally positive earnings in quarters 1-5 and quarters 11-16 relative to comparison groups (Heinrich, Mueser, and Trosker, 2008). Similarly, Hollenbeck reports that WIA Dislocated Workers tend to demonstrate fairly high opportunity costs of participation relative to WIA Adult program participants (Hollenbeck, 2009).

In general, WIA Dislocated Workers tend to perform worse than Adult workers in cost-benefit analyses even though participants in Adult programs tend to have weaker labor market participation prior to the program. At first, these results may seem perplexing. However, given the methodologies of the studies we review and our own cost-benefit analysis, this conclusion is not entirely striking. Overall, both the Heinrich and Hollenbeck studies suggest that WIA Adult workers do better than WIA Dislocated workers because Adult program participants' comparison groups are likely to have lower earnings (or little earnings). This seems to have the dual effect of depressing the opportunity costs for Adult program participants during the program and augmenting the positive changes in earnings that these participants tend to enjoy after the program compared to their peers. However, over time Dislocated Worker participants tend to enjoy stronger benefits from program participation than their peers (Heinrich, Mueser, and Troske, 2008). If we had extrapolated the changes in earnings over the lifetime, WIA Dislocated participants in Cook County would likely net higher benefits in a cost-benefit analysis.

There are additional reasons to be cautious about the results we find for both Cook County WIA Adult programs and WIA Youth programs. As we indicate above, ARRA-funded WIA Adult programs in Cook County tend to consist of more blacks than is true nationally (Workforce Development Boards of Metropolitan Chicago, 2010). Given this demographic difference and the issue of lower median earnings for blacks, net benefits for WIA Adult programs in Cook County may be closer to our lower bound estimate than the higher one. Finally, ARRA-funded WIA Youth programs in Cook County tend to be unique in comparison to other programs nationally given that the ARRA funds primarily supported paid employment in the summer of 2009. Given that participant youth obtained earnings and had little to no opportunity cost, the net benefit of the Cook County program would likely be positive within our range of estimated net benefits.

In sum, the ranges of net benefits for WIA Adult, Dislocated, and Youth services provide a glimpse of the possible returns to ARRA funds allocated to these programs. Although Cook county WIA Adult participants tend to be comprised of more blacks, our findings suggest that

the overall net benefits to this program are likely positive given that the lower bound of our estimated range is positive. Moreover, because Cook County WIA Youth programs offered paid work experience to 98% of participants, the net benefits of this program are more likely to fall on the positive rather than negative side of our range. Finally, WIA Dislocated Workers programs tend to experience higher opportunity costs to program participation and lower earnings relative to their peers within the 2.5 years following program participation. Overall, this has the effect of driving down net benefits for this particular group of workers.

Chapter 3. Public Safety

1. Overview of Programs

The public safety funds granted to Cook County from the American Recovery and Reinvestment Act (ARRA) totaled $61.8 million. This money was allocated through seven different grants, each with a different focus. Those grants were: the COPS program, the Byrne Justice Assistant Grant (JAG), a Transit Security Grant, a Rail and Transit Security Grant, an Assistance to Firefighters Grant, a Port Security Grant, and a Break the Code of Silence Grant.

The types of programs funded by the ARRA funding can be grouped into: police expenditures, transit expenditures, fire expenditures, and port security. The police expenditures included the hiring of police officers, extra money to fund overtime pay, new police vehicles, in-car cameras for existing police vehicles, and an anti-gang awareness campaign. The transit expenditures covered increasing CTA station security cameras, as well as the salaries of additional transit officers. The fire expenditures were dedicated to one program, the partial funding for a new fire station. Similarly, the port security program funded a single grant, to improve port infrastructure. There was also a catch-all category within the Byrne JAG grant which provided "personnel and various initiatives" for Cook County.

Table 1. Grant Overview

Grant	Description	Amount
COPS	50 police officers for 3 years	$13.3M
Byrne JAG	175,000 police overtime hours	$9.1M
Byrne JAG	New vehicles	$8.7M
Byrne JAG	Personnel and various initiatives in Cook County	$7.2M
Transit Security	New CTA security cameras	$6.9M
Rail and Transit Security	12 transit officers for 3 years	$4.9M
Assistance to Firefighters	Partial financing for new fire station	$4.8M
Byrne JAG	In-car cameras	$3.7M
Port Security Grant	Improved port infrastructure	$2.8M
Break the Code of Silence	Anti-gang campaign	$0.5M

The rest of this section will break down further the grants awarded to Cook County, and report sources for the baseline level of funding or infrastructure in each area. In this way, our analysis can report not just the absolute increase in, for example, police cars, but the percentage increase that the ARRA funds facilitated.

The majority of the ARRA funds, $33 million, went towards funding public safety personnel, either police officers or transit security officers. COPS grant provided money to hire

50 police officers for 3 years, and cost $13.3 million[13]. The Byrne JAG grant provided enough money for 175,000 police overtime hours to the Chicago Police Department and for nearly 65,000 overtime hours to suburban police departments[14]. In total, this translated into an additional 89 full-time officers for two years and nine officers the third year[15]. The Rail and Transit Security grant provided money for 12 transit officers for three years. Since there are 20,742 sworn officers currently in Cook County, those extra hours represented a 0.73% increase in the police force for the first and second years after the passage of ARRA and 0.34% in the third year after the ARRA funds.

The second largest use of ARRA funds was to purchase new vehicles for the Chicago police department (CPD). This came from two different Byrne JAG grants, totaling $9 million. In 2008 (which serves as the base year for all of our comparisons) the CPD fleet included 3,611 vehicles total[16]. The JAG grant is expected to spend almost half the money on 125 SUV's[17], compared to the 79 SUVs owned by the CPD. The rest of the grant is slated to purchase 108 police cruisers (compared to 1,867 marked and unmarked squad cars owned by the CPD originally, 10 squadrols (compared to 68), and five operations utility trucks (compared to 42).

The catch-all category of "personnel and various initiatives" inside of the JAG grant was the next largest grant, with $7.2 million awarded. $2.7 million of this has already been accounted for above, as it went to subsidize overtime hours for police officers or to purchase new vehicles. The remaining $4.5 million was spent on:

- New staff hires: 9 FTE for 3 years and 22.53 FTE for 2 years
- Miscellaneous Travel
- 1 Segway, 10 tasers and cameras, 10 radios, 5 rifles
- Substance Abuse and Crime Prevention Services for 673 individuals
- Substance Abuse and Crime Prevention Services as well as Legal Training for prosecutors
- Funds for management of grant and other educational and training materials:

This $4.5 million spending can be compared to the overall CPD budget. In 2008, this budget was $1.2 billion.[18]

The next biggest grantee was $6.9 million for CTA security cameras. These cameras had a stated intent to:

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13 http://www.recovery.gov/Transparency/RecipientReportedData/pages/RecipientProjectSummary508.aspx?AwardIdSur=8508&AwardType=Grants

14 http://www.cityofchicago.org/content/dam/city/narr/Transition%20Reports/Police.pdf

15 FTE calculated using Government Accountability Office standard; 2,080 hours per year equals one FTE, http://www.gao.gov/htext/d10223.html

16 https://portal.chicagopolice.org/portal/page/portal/ClearPath/News/09AR.pdf

17 http://recovery.cityofchicago.org/etc/medialib/stimulus_site/pdf_s.Par.51442.File.dat/CHICAGO-COOK%20ARRA%20JAG%20Budget%20Worksheet%20Narrative.pdf

18 https://portal.chicagopolice.org/portal/page/portal/ClearPath/News/09AR.pdf

> Harden CTA's Subway & Supervisory Control and Data Acquisition (SCADA) systems and will offer multi-user, high-density key infrastructure protection. To protect underground rail system assets and particularly underwater assets from terrorist attack by improvised explosive devices (IEDs) or other threats that can damage or significantly breach such assets. Designs for SCADA project have been prepared in-house.[19]

For a monetary comparison, the 2008 annual report lists $33.6 million spending on security by the CTA.[20] The almost seven million dollar investment in security cameras from the ARRA funds therefore represented a more than 20% increase over that.

The next largest award was $4.8 million for partial funding of a new fire station in Chicago. This added a new station to a department with 92 stations total[21]. In a city with a population of 2,695,598 in 2010[22], this increased the density of firehouses to 3.413 firehouses per 100,000 residents from 3.376 firehouses per 100,000 previously.

The next largest grant was $3.7 million for in-car cameras in Chicago Police Department cruisers. This bought 594[23] additional cameras for the CPD. We could find no official count of how many cameras are in the CPD fleet, but it is possible that there were very few cars with cameras before the ARRA grant. For example, one news article[24] mentions a baseline of 340 cars with cameras within the CPD in 2010, and this release[25] from the CPD mentions then-governor Rod Blagojevich contracting for the first 30 in-car cameras in 2006.

The $2.8 million awarded for "improved port infrastructure" through the Port Security Grant Program has been the most difficult to describe further. None of the other sources, which yielded information about the previous programs, provided any details about how that money was spent. Even the recovery.gov website for this grant gives no information on activity except for somewhat cryptic descriptions in quarterly reports[26]. The project is currently listed as "less

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[19] http://stimuluswatch.org/2.0/awards/view/9448/american-recovery-and-reinvestment-act-rail-and-transit-security-grant-program-capital-projects

[20] http://www.transitchicago.com/assets/1/board_presentations/07102008budget.pdf mentions "reduced costs" due to security cameras, so maybe getting in touch with CTA would help get a hold on how they thought cameras would translate into reduced costs

[21] http://www.cityofchicago.org/city/en/depts/cfd/dataset/fire_stations.html

[22] http://2010.census.gov/news/releases/operations/cb11-cn31.html

[23] http://recovery.cityofchicago.org/etc/medialib/stimulus_site/pdf_s.Par.51442.File.dat/CHICAGO-COOK%20ARRA%20JAG%20Budget%20Worksheet%20Narrative.pdf

[24] http://www.policeone.com/police-products/communications/articles/2031129-In-car-cameras-make-Ill-cops-uncomfortable/

[25]https://portal.chicagopolice.org/portal/page/portal/ClearPath/News/Department%20Publications/TechUpdate07.pdf

[26] For example: "Award letter was received on 9-30-09. During this period, the City completed the Environmental Historic Preservation (EHP) Forms for the approved projects and upon approval of those projects, funds are expected to be released. Identified potential vendors for projects and submitted for review to the City's Department of Procurement Services."
http://www.recovery.gov/Transparency/RecipientReportedData/pages/RecipientProjectSummary508.aspx?AwardIDSUR=47840&qtr=2009Q4

than 50% complete." Perhaps most helpful is the Port Security Grant Program description in the 2010 Homeland Security Grant overview. This document states that DHS requires that any grants have the purpose of "enhancing maritime domain awareness, enhancing risk management capabilities to prevent, detect, respond to, and recover from attacks …as well as training and exercises and TWIC implementation."[27]

The smallest expenditure was $0.5 million to fund the Campaign to Break the Code of Silence, an anti-gang initiative in Chicago. Its stated purpose is to "create public discourse about the 'Code of Silence' that stands between police and community." In effect, it is a marketing campaign, including wallet-sized "Speak-Up" cards with directions on how to use TXT2TIP and the Police hotline, and paid for the full-time salary of one Program Director for three years[28]. Breaking out CPD expenditures on anti-gang initiatives is impossible, so we can only compare this to the pre-ARRA spending on this particular initiative, which was zero.

2. Literature Review

While there may be many benefits associated with additional police personnel, the primary objective of our research is estimating the benefit associated with avoiding the crimes that do not occur as a result of the increased police presence.

2.1. Value of Reduced Crime

To estimate the magnitude of the benefit, we rely on three different studies that are frequently cited in the literature on the cost of crime.

2.1.1. Accounting-Based Method

The first two studies reviewed here, Cohen and Piquero (2009) and McCollister, French, and Fang (2010), use accounting-based methods to estimate the cost of crime. They both break down each type of crime into sub-categories, placing a dollar value on each sub-category, and then adding the components into a single estimate. The first of these papers, a 2009 study by Cohen and Piquero, updates previous research performed by Cohen in 1998. The authors divide the cost of crime into three categories: victim costs, criminal justice-related costs, and the opportunity cost of offenders.

For victim costs, the 2009 study uses an updated version of the results from Miller, Cohen, and Wiersema (1996), which breaks victim costs into two categories: tangible losses and intangible losses. Tangible losses include property damage and loss, medical care, mental health care, police and fire services, victim services, and lost productivity. Most of the data for the

[27] http://www.iaem.com/committees/governmentaffairs/documents/FY2010DHSPreparednessGrantProgramsOverview051310.pdf
[28] Cook County ARRA statistics, pulled by Professor Worthington.

Miller et al analysis is taken from the National Crime Victimization Survey (NCVS), which is one of the government's main sources of information on the impact of crime on victims. Intangible losses for crimes that resulted in death were taken from Miller's (1990) analysis of the literature on the value of a statistical life (VSL). Adjusted to 1993 dollars, this 1996 study uses $2.7 million for a VSL, of which $1.9 million was determined to measure the lost quality of life component. For nonfatal crimes, Miller et al. used jury awards to victims of crime to estimate a value for pain and suffering. They used the particular demographic variables of their national dataset on crime to model what the average jury award would be for the typical crime in their dataset. Using the estimates from this paper, for tangible and intangible losses, Cohen and Piquero simply update the estimates to 2007 dollars.

Because Miller et al. (1996) did not focus on the other components of crime such as criminal justice-related costs and the opportunity cost of offenders, for these measures, Cohen and Piquero use the methodology developed by Cohen (1998). In that paper, the author estimates the cost per offense of criminal justice system costs and of punishment costs. These estimates are based on the likelihood of a criminal advancing to each step of the adjudication process multiplied by the cost of each level. Additionally, the cost to federal, state, and local governments of housing inmates is included. For the opportunity cost of offenders, Cohen and Piquero estimate the pre-conviction legitimate wage of an inmate to be $14,626 in 2007 dollars.

This estimate is used as a proxy for the true opportunity cost of criminals. It does not include the costs borne by family members of those incarcerated because of the difficulties in accurately measuring those costs. There is uncertainty as to whether removing criminals from their family would have positive (through removing a negative role model) or negative effects on families.

Summing the victim costs, criminal justice costs, and offender productivity costs for each type of crime, Cohen and Piquero estimate the benefits of each averted crime.

Table 2. Cost of Crime Estimates from Cohen and Piquero, 2007 Dollars

Crime	Victim Costs	CJ Costs	Offender Productivity	Total
Murder	$4,600,000	$300,000	$140,000	$5,000,000
Rape	$135,000	$8,300	$4,500	$150,000
Robbery	$12,000	$7,400	$4,000	$23,000
Aggravated Assault	$37,000	$13,500	$6,400	$55,000
Burglary	$2,000	$2,300	$1,000	$5,000
Larceny	$450	$1,700	$700	$2,800

McCollister, French, and Fang (2010) follow a similar accounting-based methodology used by Cohen and Piquero. The biggest difference in the approach taken by McCollister et al. is in the chosen dollar value of a statistical life. As can be seen in Table 2, taken from Cohen and Piquero, victim costs make up the largest share of the total crime cost for violent crime. Of these victim costs, the intangible cost calculated using the VSL makes up the largest share. Therefore,

all measures of the cost of crime are highly sensitive to the VSL utilized. Using Viscusi and Aldy's (2003) aggregated estimate and inflating it to 2008 dollars, McCollister et al. find the pain-and-suffering cost of murder to be much higher: about $8.4 million. The higher VSL used by McCollister and coauthors can explain most of the difference in their estimates (Table 3 below) and Cohen and Piquero's estimates.

Table 3. Cost of Crime Estimates from McCollister et al, 2008 Dollars[29]

Type of Offense	Tangible Cost	Intangible Cost	Total Cost
Murder	$1,285,146	$8,442,000	$8,982,907
Rape/sexual assault	$41,252	$199,642	$240,776
Robbery	$21,373	$22,575	$42,310
Aggravated Assault	$19,472	$95,023	$107,020
Burglary	$7,974	N/A	$7,974
Larceny/theft	$3,523	$10	$3,532
Motor vehide theft	$10,534	$262	$10,772

Neither McCollister et al. nor Cohen and Piquero include estimates of individual or community efforts to minimize crime in their cost of crime calculations. While this may appear to be an important omission, in excluding these factors the authors actually estimate the marginal cost of crime (which, as will be described later, is what we want), rather than the average cost of crime. Cohen argues that his estimate of "marginal costs exclude such important costs as fear of crime, private security expenditures, and 'averting' behavior such as taking cabs instead of walking or changing one's lifestyle due to the risk of victimization. We exclude these costs since they are not affected by any one criminal's actions.[30]" Essentially, there is a threshold effect, where society is going to have to bear the burden of those types of costs even if there is a small decrease in crime. Since the expected decrease in crime due to the ARRA funds is small, using the marginal rather than average cost of crime is a necessary step.

However, these estimates are still not a perfect approximation of the marginal cost of crimes. For example, the authors' calculations rely on estimates of the lost productivity of the average crime victim rather than the lost productivity of a victim on the margin. Though the accounting-based method includes the tangible and intangible costs that are necessary to calculate the marginal cost of a crime, these costs are estimated using the average estimate and not the marginal estimate due to data restrictions. This could lead to a biased estimate of the true cost to society if the marginal and average estimates differ.

[29] For some of the offenses in the table, the tangible and intangible costs do not sum to equal to the total cost because the tangible costs include a 'risk of homicide' component that was include in both tangible and intangible costs. It was removed from tangible costs to avoid double counting.
[30] Cohen (1998), p. 8

2.1.2. Contingent Valuation Method

Cohen et al. (2004) use a contingent valuation approach to estimate the benefit of averting crime. Contingent valuation techniques use surveys to measure willingness to pay, in this case, the willingness to pay to avoid crime. Researchers ask individuals for their valuations of a service and estimate the respondents' willingness to pay for the service using information obtained from the survey.

The authors use a nationally representative sample of 1,300 U.S. residents. They asked the respondents if they would be willing to pay a certain amount of their own money for a crime prevention program that would prevent one in every ten of a specific type of crime. By varying the bids from $25 to $225 and the crimes in their questions, the authors then used econometric techniques to convert the yes/no responses into willingness-to-pay estimates. These willingness to pay estimates were then converted into cost per crime estimates based on the total number of crimes in the United States. The authors give a brief example of how this works in the context of burglaries:

> For example… we estimate that a 10-percent reduction in burglaries would prevent 426,123 burglaries. Because the average household is willing to pay $104 for a program that reduces burglaries by 10 percent and there are 103 million households in the United States, collectively $10.7 billion would be spent on such a program… Dividing this figure by the 426,123 crimes averted yields WTP per crime of $25,000.[31]

The same procedure is used for other types of crimes. The authors' willingness to pay estimates are shown in Table 4 below.

Table 4. Cost of Crime Estimates from Cohen et al, 2001 Dollars

Type of offense	Implied WTP
Murder	$9,700,000
Rape/Sexual Assault	$237,000
Robbery	105,454
Aggravated Assault	70,000
Burglary	25,000
Larceny/Theft	N/A
Motor Vehide theft	N/A

The contingent valuation method has benefits as well as limitation over accounting-based methods. One benefit is, unlike in the accounting-based method, if respondents internalize the different costs of particular crimes when they either accept or

[31] Example from Cohen et. al (2004), p. 99

reject the bids in the survey, then an analyst does not have to worry about forgetting to include a difficult-to-calculate cost. However, contingent valuation does not allow us to break costs down into sub-categories as in the accounting-based method and attribute parts of the estimate to tangible costs and intangible costs. Another drawback is that when survey participants respond, contingent valuation assumes that individuals are factoring in the possibility that they or their families are victims of crime and the fear that comes with it, but it is impossible to tell if respondents are internalizing larger social costs such as adjudication and incarceration. In a follow up paper, Cohen (2009) argues that individuals do include adjudication and incarceration in their estimates but he notes that there are those who believe otherwise. For example, Donohue (2007) concludes that individuals ignore social costs when responding to CV surveys.

In another limitation, contingent valuation surveys only deal with 'hypothetical' situations. People may experience a non-commitment bias and overestimate their true willingness to pay since they do not actually have to pay the amount they quote. Beyond that, even if individuals report their true valuation, there are concerns that respondents are making these decisions on poor information. Reported willingness to pay for crime prevention may vary depending on individuals' perceptions of their community's crime levels. If respondents were informed of the true levels, they may change their valuation.
As we have no reason to privilege the results of one study over another, we decided to use the average cost of crime from our three sources as we proceeded with our analysis. A table of these averages is shown below.

Table 5. Average of the Three Cost-of-Crime Estimates, 2009 Dollars[32]

Crime Type	Cost Per Crime
Homicide	$8,49,353
Rape	$225,426
Robbery	$69,612
Serious Assault	$90,265
Burglary	$13,550
Larceny	$2,213
Motor-Vehicle Theft	$9,394

[32] Inflation calculated using Bureau of Labor Statistics's Inflation Calculator, derived from CPI, http://www.bls.gov/data/inflation_calculator.htm

2.2. Effectiveness of Adding More Officers

As important as discerning the value that society places on averting crimes is, being able to quantify how effective a given intervention is at producing that benefit is just as important. For example: do we expect that adding one police officer to a police force eliminates homicide in that town? Do we expect adding that officer to reduce homicide by one-half? Would that one officer reduce motor vehicle theft at all? When the academic literature has addressed this question, the researchers have typically framed the answer in the form of elasticities. Elasticity is the percentage reduction in crime that is expected for a percentage increase in police officers.
Most of the more credible studies done on this issue have dealt with the issue of endogeneity: the outcome (crime rate) and independent variable (police officers) are correlated in both directions. It is true that more police officers may bring down a previously steady crime rate. It is also true, however, that a high crime rate may spur the hiring of more police officers. Without dealing with this endogeneity, an analyst can misstate the causal effect of hiring's effect on crime.

The most common way to deal with this endogeneity is with instrumental variables (IV). Using the IV method, a researcher finds a third variable, called an instrument, that is associated only with the independent variable. In this way, if the instrument has a change in value, and all else is held equal, if there is any change in the outcome of interest, then the researcher can conclude that change is *only* due to the independent variable.

The most-often cited work on the elasticities of crime with respect to police force is Levitt's 1997 paper "Using Electoral Cycles in Police Hiring to Estimate Effect of Police on Crime." In this paper (and his 2002 correction to it), he uses the natural experiment of the exogenous increase in police hiring that happens before municipal elections. He argues that since the hiring has to do with political reasons, rather than in response to any crime wave, the election can be used as an instrumental variable to remove the endogeneity problems.

Evans and Owens, in 2007, took a different approach to try to untangle the effect on crime of adding extra police officers to a force. Their analysis uses the monetary value of a federally-funded grant meant to increase police officer hiring. Using this as an instrument is less convincing than that of Levitt's, since the value of the grant may be less exogenous to underlying risk of crime (and thus crime rates), than municipal elections. Despite the weakness of their instrument, however, this study is very relevant to the Chicago analysis since it analyzes the COPS program. The COPS program is the same program implemented by Chicago to hire $13.3million worth of full-time police officers with ARRA funds, as discussed above.

Similar to the Levitt paper, Klick and Tabarrok (2005) also found a credible exogenous shock to police personnel to use as an instrument: the federally-set terror alert. Using crime data taken by the Washington DC police department, the authors analyzed the effect of the extra public safety officers who are deployed when the terror alert was raised by the Department of Homeland Security.

Di Tella and Schargrodsky (2004) also used the IV approach. Their paper analyzed motor-vehicle theft in Israel in the time period after a terrorism attack against Jewish targets in

Argentina. In the weeks after the terrorist attack, police presence was increased around Jewish institutions in Buenos Aires, and this seemed to have a localized but statistically significant deterrence against motor vehicle theft. Rather than use an IV, Corman and Macan (2000) used analytically sophisticated time-series techniques. Their dataset was a detailed list of crimes in New York City over 30 years, and they estimated elasticities of violent crime with respect to police staffing for several different categories of crime.

Since we have no reason to privilege the conclusions of one of these studies over the others, we use the average elasticities from these five studies in our analysis. The summary of this literature review is below, in Table 6.

Table 6. Elasticities of Crime With Respect to Police Officers[33]

Crime Type	Election-Cycle IV (1)	COPS Grant IV (2)	Time-Series (3)	Terror Level IV (4)	Terrorism IV (5)	Average
Homicide	-0.914*	-0.84*	-1.385			-0.927*
Rape	-0.034	-0.42				-0.170
Robbery	-0.452*	-1.34*	-0.526*			-0.592*
Serious Assault	0.397	-0.96*	-0.288			-0.292*
Burglary	-0.195	-0.59*	-0.419*	-0.30*		-0.404*
Larceny	-0.135	-0.08				-0.103
Motor-Vehide Theft	-1.698*	-0.85*	-0.452	-0.86*	-0.33*	-0.440*

* Estimates are significant at the 95% level
(1) Levitt, 2000
(2) Evans and Owens, 2007
(3) Corman and Macan, 2000
(4) Klick and Tabarrok, 2005
(5) Di Tella and Schargrodsky, 2004

3. Case Study: Increased Police Personnel in Cook County

3.1. Methodology

In estimating the net social benefits of increased police personnel in Cook County, we adopted the framework outlined by Heaton (2010). First, we used as the baseline level of violent crimes the average of each type of crime in Cook County from 2006 to 2008.[34] The crimes that we focused on were Type 1 crimes, as defined by the FBI: homicide, rape, robbery, serious assault, burglary, larceny, and motor-vehicle theft.

[33] The elasticity measures estimate the impact of a 1% increase in police personnel on each crime type. For example, the average for Homicide tells us that a 1% increase in police personnel is associated with a 0.927% decrease in homicide.

[34] The seven different types of crime we will focus on are homicide, rape, robbery, serious assault, burglary, larceny, and motor-vehicle theft. Data on crime levels is from illinoisdata.com.

Second, we used data from the Illinois State Police to determine the baseline number of police in Cook County at the end of 2008.[35] The baseline level of 20,742 officers included all full-time sworn officers from the 120 police departments listed for Cook County as well as the Cook County Sheriff's Department.

Third, we used this 2008 baseline of officers to calculate the percentage change in officers resulting from ARRA funds. We focused on the additional officers added as a result of the Rail and Transit Program, COPS Program, and Byrne Grant. These three programs added a total of 151 officers for 2009 and 2010 and 71 officers for 2011[36]. This translated into a 0.73% increase in the first two years and a 0.34% increase from our baseline in the third year.

Fourth, we used the average elasticity measures from the articles mentioned previously to determine the expected number of each type of crime that would be averted as a result of increasing police personnel.

Fifth, we multiplied the above result by the baseline number of crimes (calculated earlier) to determine the number of crimes that are expected to be averted as a result of increased police personnel. We only used those elasticities that are statistically significant at the 95% level. We therefore assumed that increasing personnel would have no effect on the amount of rape or larceny[37].

Sixth, we used the average of the cost of crime estimates found in the literature and inflate to 2009 dollars to estimate the value of each averted crime. We multiplied the number of averted crimes for each type by the benefits of an averted crime of that category to find the expected savings for each crime.

Seventh, we summed the total protected savings for each type to find our gross benefits of increased personnel. Steps one through seven are repeated for each year with the appropriate adjustment for personnel levels to find each year's gross benefits.

Finally, we subtracted each year's program costs from the estimated gross benefits to calculate yearly net benefits. The net benefits were discounted using a 3.2% discount rate to give us our present discounted value of the programs' net benefits. We conclude that the initial $32.65 million investment yields $110.28 million in discounted gross benefits for a net benefit of $77.63 million.

[35] Data for police levels taken from http://www.isp.state.il.us/docs/cii/cii08/cii08_Section_V_Pg213_to_236.pdf

[36] Overtime hours were assumed to be divided evenly between the first two years and were computed to full-time equivalents with 2,080 hours equal to 1 FTE.

[37] None of the studies we examined offered a hypothesis as to why the elasticities for rape and larceny were not statistically significant. We speculate that these crimes might be more likely to occur between people who are somewhat acquainted with one another and therefore be more difficult to prevent through a larger police presence.

3.2. Results

Tables 7, 8, 9, and 10 present our specific calculations. Table 7 reports our benefits calculations for year one. Table 8 reports our present value calculations for the three years studied. Table 9 reports the yearly breakdown of additional officers for the three programs. Table 10 reports the net benefits calculation.

Table 7. Year one costs savings (year one benefits) of 0.73% Increase in Police Personnel in Cook County

Crime Type	Average Yearly Number of Crimes, 2006-2008	Elasticity	Projected Crimes Averted from Increase in Police	Cost Per Crime	Projected Cost Savings
Homicide	560	0.927%*	3.78	$8,949,353	$33,864,814
Rape	2,254	0.17%	0	$225,426	$0
Robbery	18,898.33	0.592%*	81.55	$69,611	$5,676,961
Serious Assault	20,644	0.292%*	43.94	$90,265	$3,966,246
Burglary	37,080	0.404%*	109.2	$13,550	$1,479,680
Larceny	137,949.00	0.10%	0	$2,213	$0
Motor-Vehicle Theft	25,729.00	0.440%*	82.52	$9,394	$775,207
Aggregate cost savings					**$45,762,909**

* Indicates statistical significance at 95% level

Note: Cost Per Crime estimates are found in Table 4 and Elasticity estimates are found in Table 5

Table 8. Present value of cost savings (benefits) over three years of ARRA funding

Year 1	$45.8
Year 2	$44.3
Year 3	$20.2
Total	**$110.3**

Table 9. Additional Personnel Per Year and Costs

Program	Officers Year 1	Officers Year 2	Officers Year 3	Cost
Rail and Transit Program	12	12	12	$4,869,000
COPS	50	50	50	$13,256,100
Byrne JAG	89	89	9	$14,528,590
Total	151	151	71	**$32,653,690**

Table 10. Summary of Costs and Benefits, in millions

Gross Benefits	$110.3
Cost	$32.7
Net Benefits	**$77.6**

We also repeated this analysis, confining the benefits and costs only to those accrued by the city of Chicago. We found that $27.2 million of the $32.6 million in spending was focused in Chicago. The city of Chicago-level analysis included full-time sworn officers from the Chicago Police Department and a fraction of the Cook County Sheriff's Department.[38] Following the same methodology used for Cook County, we find that the $27.2 million in spending yields $95.1 million in discounted gross benefits and $67.9 million in discounted net benefits.

Comparing the two geographic analyses, we see that the additional $5.4 million spent outside of Chicago yielded $15.16 million in gross benefits. This gives us a benefit-cost ratio of 2.79. As a comparison, when restricting the standing only to Chicago, the benefit-cost ratio increases to 3.49. Because of the high cost of homicide, most of the benefits come from averted murders. The higher benefit-cost ratio for Chicago compared to the suburbs is due to the fact that Chicago has a higher ratio of homicides per police officer. An additional police officer therefore has a larger effect in Chicago than the rest of Cook County. Increased police personnel both in Chicago and outside of Chicago yield positive net social benefits, but the higher benefit-cost ratio is found when limiting the analysis to spending and benefits within Chicago.

This analysis is not a study of the most efficient deployment of police resources, but the results here are suggestive. Because the elasticities of crime with respect to police presence differ significantly across types of crime, and since a prevented homicide is so much more valuable than any other crime, this suggests that any given level of police resources could "add more value" (or provide more benefits) by being directed to homicide prevention activities. This is relevant to the comparison of police allocation between Chicago and the rest of Cook County as well as to the allocation within Chicago. A more thorough study of the allocation of resources should also account for the degree to which various crimes are correlated- whether police strategies that reduce homicide, for example, are also likely to impact other crimes as well.

3.3. Sensitivity Analysis

Our calculation of net benefits is highly dependent on the estimates that we use of the cost per crime and of elasticity. To test the robustness of our results, we use high, medium, and low estimates for both elasticity and cost per crime (the medium estimates are the same values used in our earlier analysis). The estimates for cost per crime are taken from Tables 2, 3, and 4 and the estimates for elasticity are taken from Table 6. Table 11 shows the discounted present value net benefits in nine possible scenarios. In all scenarios we find positive net benefits with the results ranging from $15.1 million to $253.2 million.

[38] The Illinois State Police Report estimates that 53% of Cook County population is in Chicago. We therefore included 53% of the Cook County Sheriff Department in our base estimate of police in Chicago.

Table 11. Sensitivity Analysis

Cost per Crime	Elasticity: High	Elasticity: Medium	Elasticity: Low
High	**$253,236,310**	$126,350,983	$87,841,604
Medium	$164,087,638	**$77,630,871**	$53,144,955
Low	$77,117,063	$28,269,757	**$15,056,935**

3.4. Discussion

The validity of our results is highly dependent on the accuracy of our assumptions and of our model. This section describes several ways in which both our assumptions and model may be inadequate and how future sensitivity analysis could provide us with an appropriate range for our results[39]. First, in calculating our costs, we assume that there were no additional costs to Cook County besides salaries. Cook County received additional ARRA funding for equipment, but it is likely that police departments needed to bear additional overhead costs as a result of hiring additional officers. Until we determine the true costs of adding additional officers in this way, our estimate may be overstating the program benefits.

Second, ideally our analysis would use the cost of the marginal crimes averted. As discussed in the literature review, our estimates of the cost of crimes only approximate the marginal crime costs. Some of the components of our crime estimates rely on averages and therefore likely overstate the true net benefits, if the marginal crime averted is of a lower value than the average.

Third, our data on crime levels were taken from the Illinois State Police, and therefore only uses reported crimes. This is likely an understatement of the number of crimes committed. Other data sources, such as the National Crime Victimization Survey, use surveys to estimate the actual number of crimes rather than just the reported number. It is likely that using the NCVS instead of the state police data would yield a higher crime baseline and thus larger net benefits.

Fourth, police likely produce benefits besides just reducing the seven crimes we focus on. To the extent that we do not include these estimates, we are underestimating the true benefits of increased personnel.[40]

Finally, we defined our relevant population as Cook County. It is unclear if crimes are actually completely prevented in Cook County or just shifted elsewhere. If shifted elsewhere, it is also unclear if we should concern ourselves with the status of those outside of our region of focus.

[39] Part of our discussion of elasticities is adapted from Levitt (1997). For a more detailed description of the problems associated with using crime elasticities to measure net social benefits, see Levitt (1997).

[40] Cohen (1996) estimates that of the $450 billion of the estimated annual cost of crime in the United States, $426 billion comes from violent crimes and only $24 billion from property crimes. Therefore focusing our analysis on violent crimes seems warranted.

4. Conclusion

Building on the academic literature, we designed and implemented a cost-benefit analysis of the increased police personnel in Cook County resulting from ARRA grants. Using our preferred estimates, we find net benefits of $77.64 million. Using a range of additional estimates, we continue to find positive net benefits, from a low of $15.1 million to a high of $253.2 million, lending support to the robustness of our results. In total, we focused on $32.7 million in ARRA grants. This comprises 53% of all public safety grants. Further research should build on our analysis and estimate the impact that the remaining 47% of public safety ARRA grants had on Cook County.

Chapter 4. Housing

1. Introduction

1.1. The U.S. Housing Crisis

Since its beginnings in 2006, the housing crisis has continued to challenge communities across America in what is now recognized to be one of largest economic recessions in the nation's history. Despite countless efforts to counter the negative impacts of the housing crisis, by 2010 home prices had declined by almost 30 percent from their peak in 2006, according to the Case-Schiller Home Price Index, and over a million homes have been repossessed by banks (Marketwatch 2010 & RealtyTrac 2010). Notwithstanding, it is expected that the peak of foreclosure activity will not come until well into 2011, with RealtyTrac predicting that the number of U.S. homes receiving a foreclosure filing is likely to peak through an increase of 20 percent from 2010 levels (2010). Already, one in every 593 housing units has received a foreclosure filing by April of 2011 corresponding to a total of over 1.8 million foreclosed homes (RealtyTrac 2011). Additional proof that the housing crisis is far from over is provided by a recent report that estimates a further 1.8 million homes seriously delinquent, in the foreclosure process or Real Estate Owned (REO) that are not currently listed for sale – also known as shadow inventory (Core Logic 2011).

1.2. The Housing Crisis in Chicago

As would be expected, Chicago has not been spared from this countrywide trend. In 2010, the City had the second highest decline in home property values among 20 U.S. metropolitan areas - 7.6 percent from the previous year's 8.5 percent annual drop (Chicago Sun Times 2011). As a result, in 2010 the City had a total of 23,364 foreclosure filings, corresponding to 41.1 filings per 1,000 mortgageable properties – the second highest for the Chicago six county region (Woodstock Institute 2011). Overall for the Chicago six county regions, 79,986 new foreclosure cases were filed in 2010, corresponding to a 38.1 percent increase over 2008 (Woodstock Institute 2011). Already, first quarter foreclosure filings for 2011 show an increase of 7.2 percent compared to the first quarter of 2010 for Cook County. In addition, there were 18,320 properties on the City's vacant building index as of September 2010, of which 69.2 percent were associated with a foreclosure filed between 2006 and the first half of 2010 (Smith & Duda 2011a).

Interestingly, recent trends show that foreclosure filing seem to be concentrated in the region's middle and upper-income urban and suburban communities. For example, according to the Woodstock Institute (2011), the greatest increases in new foreclosures fillings between 2009 and 2010 include McHenry County (33 percent) and Will County (21.4 percent). Similarly, although the City of Chicago as a whole saw only a small increase in foreclosure filings (3

percent) in 2010, neighborhood increases varied dramatically, with the Loop (53.7 percent), the Near South Side (44.9 percent) and Lincoln Park (34.6 percent) experiencing sharp increases. In contrast, foreclosure filing rates declined in some of the regions' modest-income communities of color that were the most affected in the early years of the crisis. Thus, Washington Park experienced a 19.3 percent decrease in foreclosure filings, while Hermosa (16.7 percent) and West Englewood (16.2 percent) followed closely behind. Notwithstanding, the region's South Cook County (50.9 per 1000 mortgageable homes) and City of Chicago (41.1 per 1000 mortgageable homes) continue to have the largest number of new foreclosure filings per property.

Historically, the communities most heavily impacted by Chicago's foreclosure problem were mostly concentrated on the west and south sides of the City. As shown by recent evidence, this continues to be the case. For example, as we have already noted, citywide data for 2010 shows that there were 41.1 foreclosure filings per 1000 mortgageable properties. However, in communities such as Austin, Englewood, Humboldt Park, Washington Park, West Englewood, West Garfield and Woodlawn, foreclosures among 1,000 mortgageable properties ranged from 46.3 to over 134 (Woodstock Institute Factbook)[41].

Furthermore, access to mortgage refinance loans has sharply declined in communities of color across the country. In Chicago in particular, while conventional refinance originations in predominantly white neighborhoods increased by 102 percent from 2008 to 2009, for the same period, these declined by 41 percent in communities of color (California Reinvestment Coalition et al 2011). Similarly, women are making up a larger share of bankruptcy filings in Cook County with the share in African American communities being substantially larger. Between 2006 and 2010, women filed for bankruptcy at a rate of 2.6 per 100 adult women, while in African American communities this figure was 5.1 per 100 adult women. Overall, households headed by women in African-American communities represented the largest share of bankruptcy filings – 16.7 percent of all cases in Cook County between 2006 and 2010 (Smith & Duda 2011b).

1.3. American Recovery and Reinvestment Act Funding for the Housing Sector

As we have seen, the concentrated numbers of foreclosures have been threatening communities across the country, and Chicago has been no exception. Where some analysis suggest the housing crisis was primarily driven by predatory lending and inflated real estate prices, the continued rate of foreclosures has been exacerbated by the prolonged economic decline and the resulting job losses. Regardless of the cause, the continued flow of foreclosed, vacant and abandoned homes has a substantial effect on local housing markets and threatens the vitality of affected communities.

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[41] The following are the corresponding figures by community: Austin (46.3), Englewood (50.3), Humboldt Park (56.7), Washington Park (134.3), West Englewood (51.4), West Garfield (65) and Woodlawn (87.6).

As a result, the U.S. Congress, through the Department of Housing and Urban Development (HUD), has undertaken a number of unprecedented actions in an effort to stabilize the housing and financial markets while preventing future job losses and promoting economic recovery. In 2008, as part of the Housing and Economic Recovery Act, the Neighborhood Stabilization Program (NSP) was created to provide over $3.9 billion in funding targeting the hardest hit areas while helping communities address the problems of vacant, abandoned and foreclosed homes. In May 2009, as part of the American Recovery and Reinvestment Act (ARRA), the NSP was extended for a second phase - referred to as NSPII – providing over $1.9 billion in federal grants. Although a third phase was approved in September of 2010 as part of the Dodd-Frank Wall Street Reform and Consumer Protection Act for an additional $1 billion in funding, the program to be analyzed in the remainder of this chapter refers solely to funding provided through the NSPII.

For the City of Chicago, three main housing programs – the NSPII and two Community Development Block Grants for Foreclosure Prevention Counseling and Outreach Events - received a total of $101 million dollars of ARRA funding to support innovative foreclosure prevention and neighborhood stabilization strategies at the local level in Chicago (See Table 1). Of note, all three programs were pre-existing initiatives directly related to foreclosure prevention and neighborhood stabilization, which allowed for swift incorporation of the additional ARRA funding by taking advantage of pre-existing platforms.

Table 1. ARRA Housing Sector Funding for Chicago

Component	Neighborhood Stabilization Program	Foreclosure Prevention Counseling	Foreclosure Prevention Outreach and Events
Grant and Funds ($)	NSPII Grant *Funds: $98,008,384*	Community Development Block Grant- Recovery *Funds: $1,875,000*	Community Development Block Grant- Recovery *Funds: $1,025,000*
Recipient(s)	Mercy Portfolio Services will manage funds as a sub-recipient under the Chicago Department of Community Development	Distributed among 25 existing community organizations to support foreclosure prevention counseling	Distributed to Neighborhood Housing Services of Chicago to continue "Fix Your Mortgage" events
Objective	Build on existing structure of NSP I: *Chicago Housing Authority *Competitively Selected Developers *Financial and Acquisition Partners *Community Partners	Support existing neighborhood networks of foreclosure prevention programs	Add additional resources to citywide foreclosure outreach and events

1.3.1. The Neighborhood Stabilization Program II ($ 98,008,494)

The NSPII was by far the largest component of ARRA funding for the housing sector, corresponding to close to 98 percent of all housing-related funding for the City. The program goal was to reverse the decline in home sales and support local economic development in targeted neighborhoods by purchasing and redeveloping foreclosed and vacant housing (City of Chicago 2011). Mercy Portfolio Services was selected to manage the funds as a sub-recipient under the Department of Community Development (recently renamed the Department of Housing and Economic Development). Mercy is responsible for negotiating discounted property purchases with the lending institutions that hold those properties. This agency acts to hold and maintain the property for the short term and oversees a broad network of pre-approved development partners on property rehabilitation and development. Once the sale is complete, Mercy adjudicates a transfer (acting much like a subsidy) to the corresponding development agency. Overall, more than 50 competitively selected developers**,** both non-profit and for-profit, are already working on NSPI and are pre-qualified for NSPII.[42]

According to the NSP quarterly reports, NSPII is using the pre-existing platform of NSPI to distribute the additional ARRA funding. These funds will be funneled to specifically targeted neighborhoods, which include 36 census tracts in 12 communities, spanning the South, West and North Sides. These tracts have an average of 66.6 foreclosure filings per 1000 mortgageable homes in 2010, a median of 53.7 as well as a minimum of 39.2 in South Lawndale and a maximum of 134.3 in Washington Park (Own Calculations based on Woodstock Institute Factbook) [43]. While these communities are not necessarily the hardest hit by foreclosures and face different levels of difficulty responding to the foreclosure crisis, they share the common challenges of widespread foreclosures, job losses, declining populations and low education levels (NSPII Application Form). Overall, using adjusted cost estimates from the first round of implementation, the City intends to: (1) Rehabilitate and reuse 1,331 housing units; (2) Demolish 182 blighted, residential structures; and, (3) Construct 27 homes on demolished sites (Chicago NSP 2010).

1.3.2. Foreclosure Prevention Counseling ($1,875,000)

Through a community development block grant, the Department of Community Development directed the funds towards the efforts of 25 pre-existing counseling agencies intended to prevent or mitigate foreclosures in Chicago neighborhoods (See Annex 1). While increasing the means for general program support, a majority of the allotted funds were used to

[42] http://recovery.cityofchicago.org/stimulus/en/narrative/investment_categories/housing/neighborhood_stabilization0.html

[43] The 12 communities are: Albany Park (53.8 foreclosure filings per 1000 mortgageable homes in 2010), Chicago Lawn (60.9), Englewood (50.3), Grand Boulevard (130.8), Greater Grand Crossing (47.3), Hermosa (53.6), Humboldt Park (56.7), Logan Square (41), South Chicago (44.1), South Lawndale (39.2), Washington Park (134.3) and Woodlawn (87.6).

pay the salaries of 28 additional housing counselors who provide foreclosure prevention counseling to individuals at risk of losing their homes, pre-purchase counseling to new homebuyers, and counseling assistance to renters evicted due to building foreclosure (City of Chicago 2011b). Even though each organization may have a different approach to foreclosure prevention counseling, they all offer free services that focus on communication with lenders, clear explanations of financing solutions and provide trained housing counselors that help evaluate the client's financial situation (Neighborhood Housing Services 2011a).

1.3.3. Foreclosure Prevention Outreach and Events ($1,025,000)

The ARRA funds allocated for foreclosure prevention outreach and events were directed to the Neighborhood Housing Services of Chicago in order to support program service delivery costs, marketing/outreach materials, and site and equipment rental for events designed to connect homeowners facing foreclosure with assistance within targeted areas in Chicago (City of Chicago 2011b). This particular program assists homeowners in completing and submitting loan modification applications, as well as providing support for follow-up and further processing procedures**.** These free events are typically two hour workshops hosted by various community centers across the City that provide one-on-one assistance and financial services for up to 30 community members in several languages (Neighborhood Housing Services 2011b).

2. Literature Review

2.1. NSP Program Evaluation

The NSP program is a relatively new initiative that is yet to be the subject of an interdependent program evaluation by a reputable agency. As indicated earlier, the first round of NSP funding was allocated in 2008. According to the Federal Reserve Bank of Chicago, Community Affairs researchers across the Federal System began a study in 2009 evaluating the planning and implementation of the program at the federal level. The study, initially planned for release in the Fall of 2010, was to include interviews and other data on local capacity as well as early program outcomes in order to analyze various implementation challenges and possible best practices (MORE Report 2010). The MORE report mentions that this planned study will also provide the first nationwide examination of the early stages of the NSP[44].

Additional reports that solely focus on the NSP program are predominantly interested in providing case studies and implementation strategies, rather than evaluating the impact of the program on neighborhoods and communities. NeighborWorks America (2010, 2011a & 2011b) has provided several reports of this type, offering detailed information on over 20 case studies in towns and municipalities throughout the country.

[44] To date, we have no knowledge that this report has been released or made available to the public.

2.2. Foreclosure Prevention Counseling Evaluations

According to Hornburg (2004), there is a relatively limited body of research on the effectiveness and impact of homeownership counseling. The homeownership counseling industry is situated within a rapidly changing and growing financial services industry that has witnessed an array of developments, including an increase in specialized financial services, within the last two decades. This growing industry has engendered the need for consumers to become increasingly more informed about the financial options available to them, resulting in a heightened interest in financial literacy programs. These include pre-purchase counseling programs and delinquency-default programs, with foreclosure prevention counseling most often referring to the latter.

In the numerous studies examined by Hornburg (2004) and Strauss (1997), it is often implied that foreclosure prevention counseling is effective, without empirically stating the positive effects. Hornburg points out that the lack of good empirical evidence is often attributed to a high degree of heterogeneity among the different programs. Furthermore, McGilvray (2000) highlights that the main barrier to researching the counseling effectiveness of foreclosure prevention programs remains the lack of a consistent standard for data collection. As the author points out, many practitioners have an aversion to providing data for formal research since it may require that the various institutions offering counseling services redirect their often limited resources towards outside interest, as opposed to concentrating on counseling service provision.

Notwithstanding, this is not always the case as demonstrated by the Neighborhood Housing Services (NHS) of Chicago, an organization that places a profound importance on data collection, including the provision of an annual report indicating foreclosure prevention activities and outcomes. In 2010, the NHS provided personal counseling services to over 4,000 families, with an additional 2,800 families attending a foreclosure prevention class (NHS 2010). Similarly, the NHS assisted 1,010 families in avoiding foreclosure in Chicago with about 76 percent of these “saves” achieved through personal counseling services (NHS 2010). Even though the data provided by NHS may be quite narrow in scope, they have developed a standard method of counseling and data collection that can serve as a starting point for similar organizations and/or initiatives.

3. Cost-Benefit Analysis Methodology

Foreclosed and vacant homes affect neighborhoods in many ways. Besides causing financial, emotional and physical effects on those who are losing their home, foreclosures also harm surrounding neighbors. Recent studies by Immergluck & Smith (2006a) and Harding et al (2009) have shown that each foreclosed or vacant property reduces the values of other properties within 1/8 of a mile or closer by roughly one percent, while others (see Mallach 2009) have indicated even larger effects for those properties directly adjacent to blighted structures. The decrease in property values can result in lower tax revenues for local government, which in

response may need to cut back city services provided in the area. Notwithstanding, government could also increase the tax rate to compensate for the windfall and possibly adversely affect already depressed areas. Furthermore, vacant properties also attract elements of crime and may pose safety concerns for nearby residents, while also increasing municipal costs in a variety of ways. As foreclosures become concentrated within a neighborhood, these negative trends can spill beyond the immediate area to the wider community, causing a downward spiral that affects cities on a greater scale (Levi 2009).

From this literature we derive the main impact measures that will be used in the analysis of NSPII. In addition, we also include a measure of the municipal costs that are associated with the foreclosure process in the City of Chicago as based on estimates derived from Apgar and Duda (2005). Finally, it is important to note that one of the main ways that foreclosures harm neighborhoods is through violent crime generated by extended vacancies and abandoned buildings. For instance, Immergluck and Smith (2006b) using data from foreclosures, neighborhood characteristics and crime from the City of Chicago, conclude that higher foreclosure levels contribute to higher levels of violent crime. Overall, the author's findings suggest that a one percent increase in the foreclosure rate is expected to increase the number of violent crimes in a census tract by as much as 2.33 percent. Though, Immergluck and Smith find that the results for property crime are not statistically significant. Notwithstanding, for the remainder of the analysis it is deemed reasonable to assume that much of the costs associated with increased criminal activity in the corresponding communities will be reflected on the price of the housing units.

3.1. Estimating Decreases in Property Values

In order to estimate the decreases in property values resulting from the existing stock of foreclosed properties, a composite methodology developed by the previously mentioned literature will be implemented. Building on a recent study by the Center for Responsible Learning (CRL) (2009) we assess the impact of foreclosed or vacant properties on neighboring homes by using data on the density of local housing units and median house prices for each census tract. Assuming that the predicted foreclosures within each census tract are evenly distributed throughout the tract, we calculate the number of foreclosures expected to be within 1/8 of mile of each non-foreclosed home. In other words, for a given census tract:

Let A be the total area in square miles;

B be the imputed number of NSPII houses rebuilt or rehabilitated in each tract that is assigned proportionate to the number of foreclosures;

C be the total number of housing units;

D be the median house price by tract;

The variable G is equal to $64A/\pi$. This measure tells us the number of circles with a $1/8^{th}$ of a mile radius that can fit into each tract.

Then the number of foreclosed homes within$1/8^{th}$ of a mile of any given home in the tract experiencing devaluation is given by: H = B/G (CLR 2009). Correspondingly, the dollar amount of the decrease in house value from the foreclosure effect is given by the estimated percentage decrease in house values due to neighboring foreclosed properties. Based on findings by Harding et al (2009), if there are 3 or more foreclosed properties, it is assumed to correspond to a 3 percent decline in property values, while if there are less than 3, a 1 percent decline per foreclosure is used.[45].

For the NSPII impact effect on property values, we will use the number of purchased, rehabilitated and rebuilt or demolished properties (1513) to recalculate the number of foreclosed or vacant properties and estimate the effect of taking these properties off the "vacant list." This will give us the costs avoided by preventing the decrease in property value of surrounding structures by rehabilitating those problematic properties.

3.2. Municipal Costs of the Foreclosure Process

As previously mentioned, Apgar and Duda (2005) review the foreclosure process in the City of Chicago and isolate 26 separate costs which are incurred throughout the foreclosure process as well as related services. These costs reflect actions taken by 15 separate governmental units that are part of the overall municipal infrastructure underlying the foreclosure process. The paper provides an in depth look at the range of characteristics that foreclosures can exhibit and the related costs which may include demolition fees, building inspections, legal expenses, court costs and an increased burden on fire departments due to vandalism.

In a "simple foreclosure," which the authors define as a property that has completed the foreclosure process without ever being vacant, as many as six separate Cook County departments are involved. As the process of foreclosure encounters complications, the costs and number of governmental units involved often increase dramatically. According to Apgar and Duda, the foreclosure process typically lasts 13 months in Illinois, which means a building may remain vacant and unsecured for months. For as long as a unit is vacant, it is often accessible to “vandals, squatters, and criminals” regardless of any efforts to board and secure it, which can often be ineffective. The various costs that the local government can accrue due to complications during the foreclosure process, depending on the state of the housing unit, are summarized in Table 3.

Based on these estimates, we calculate the NSPII impact effect on municipal costs, using the different states of the properties within our sample. That is, for the City of Chicago, vacant

[45] Thus, if H > 3, then 3 percent*C*D, if H < 3, then 1 percent* H*C*D. In essence, this provides the basis for a calculation of total averted losses from prevented foreclosures.

and secured properties are estimated to incur municipal costs of $430, vacant and unsecured properties sustain charges valued at $5,338 and vacant, unsecured to be demolished properties experience costs of $13,452 (Adgar and Duda 2005).

Table 3. Costs of Foreclosures to Local Government (Apgar and Duda 2005)

	A	B	C	D	E
	Vacant & Secured	Vacant & Unsecured Conserve.	Vacant & Unsecured Demolished	Vacant & Unsecured Abandoned	Abandoned & Fire Damage
Cost	$ 430	$5,358	$13,452	$19,227	$34,199
Lis Pendens filing	■	■	■	■	■
Chancery court, register sale, new owner	■	■	■		
Vacancy intake, inspection, maint. registry	■	■	■	■	■
Serve notice to secure		■	■	■	■
Boarding, lien issuance		■			
Prepare/hold administrative hearing		■			
Police call			■	■	■
Demolition notices			■	■	
Contractor demolition, lien issued			■	■	
Property tax loss from demolition			■	■	■
Prepare/conduct demolition court					■
Unpaid property/utility tax losses				■	■
Unpaid water, mow lawn, remove trash				■	■
Fire suppression					■

4. Cost-Benefit Analysis Results

Our preliminary results show that the impact on averted property value losses results in a gross benefit of approximately $114.47 million. Importantly, it is worth noting that the analysis only focused on owner-occupied housing and not on rentals or commercial property. Table 4 provides insight into the averted property value calculations with an additional and more detailed analysis provided in Annex 2.

Table 4. Averted Property Value Declines (or "Losses")

	Total Foreclosures	Total Owner Occupied Units	Total Median House Price*	NSP Rehabilitated/Rebuilt Homes**	Avoided Decline in Property Value***
Totals	**2004**	**15,381**	**$ 8,394,700**	**1513**	**$ 114,468,227**

* Total Median House Price for Owner Occupied Units Within Corresponding Census Tracts

** Imputed number of houses rebuilt/rehabilitated by the NSP in each tract, assigned proportionate to number of foreclosures

*** 1% decline per foreclosure if less than 3 foreclosures and 3% decline thereafter

To estimate the municipal costs associated with properties in foreclosure, we first calculated the proportion of properties under each of the possible scenarios. According to Smith and Duda (2011) since the City of Chicago strengthened its vacant building ordinance in 2008, requiring owners of properties that are vacant over 30 days to register their properties with the City and pay a $250 registration fee, it is sensible to assume that those properties not registered are likely not secured up to the standards defined by the City. As a result, Smith and Duda estimate that of the 4,478 single-family properties still in the REO inventory in Chicago at the end of the third quarter of 2010, 2,558, or 57.1 percent, were not registered with the City as vacant buildings. Using these estimates, we estimated that there are a total of 572 vacant and secured properties in the City of Chicago accruing municipal costs of $430, 759 vacant and unsecured properties with municipal costs corresponding to $5,358 and 182 properties that are currently vacant, unsecured and to be demolished at a cost of $13,452. Given these numbers, the total of avoided municipal costs from the NSPII program is $7.88 million[46].

Finally, by considering the NSPII grants as a transfer scheme, it can be regarded as providing a benefit equal to the total amount of grants administered, which is approximately $98 million. Consequently, adding these benefits we obtain a gross benefit for the NSPII program of $220.35 million and a net benefit of $122.35 million. Notwithstanding, even if we consider the transfer to be a cost, as opposed to neutral, the benefits of the program remain positive ($24.35 million) although substantially reduced.

Table 5. Summary Results

Benefits	
Avoided Municipal Costs	$ 7.88
Avoided Property Value Declines	$ 114.47
NSPII Program Transfer	$ 98
Gross Benefits	*$ 220.35*
Costs	
NSPII Program Transfer	$ 98
Net Benefits	***$ 122.35***

5. Conclusions and Recommendations

In 2010, banks foreclosed on a record number of properties and it is predicted that the peak of foreclosure activity will not come until well into 2011. Over the course of the crisis, high concentrations of distressed foreclosed properties have threatened neighborhood stability and economic opportunities, resulting in costs far greater than the values of these homes. With declining property values and increasing vacancies and abandonment, the social and economic fabric of entire neighborhoods is deteriorating. Rebuilding that fabric is a complex and costly endeavor, which often requires broader steps than simply removing or blighted and vacant properties from a neighborhood (Mallach 2009). Notwithstanding, as we have seen with the NSPII, such initiatives can provide benefits to distressed communities that can further have a

[46] These benefits are presented in 2009 US dollars, as are the rest of the figures in the CBA. The original estimates derived from Adpgar and Duda (2005) use 2003 US dollars as their base.

stream of positive spillover effects. In the case of the NSPII, the net benefits of the program, $121.23 million, by far exceeded the investments.

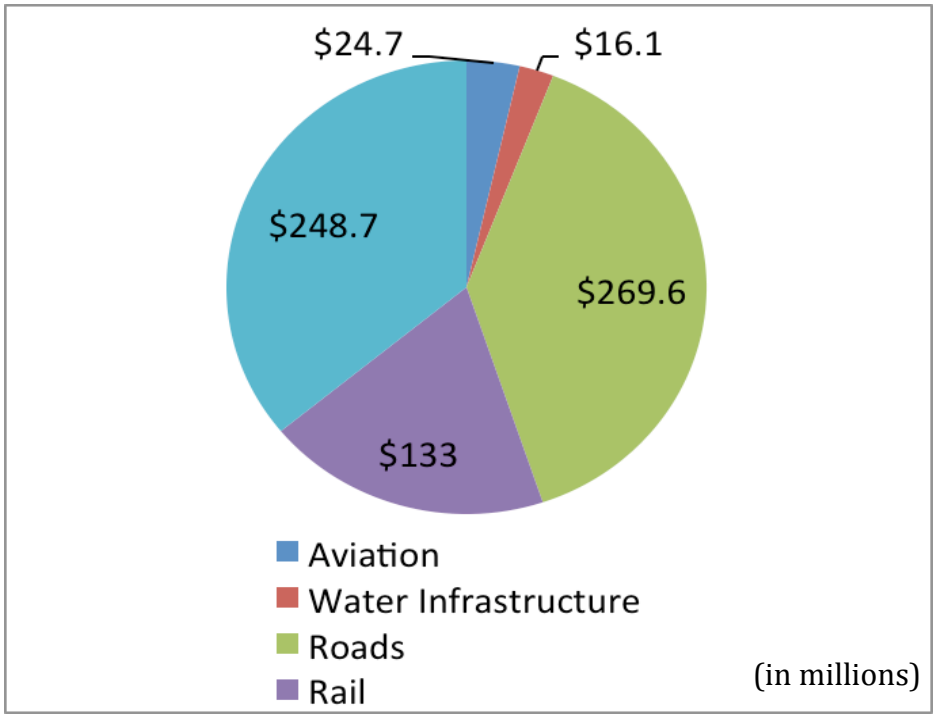
Furthermore, one of the ways that ARRA funds have been distributed to deal with deteriorating neighborhood effects is to offer foreclosure counseling and outreach for owners and renters that are struggling to stay in their homes. This attempt to stabilize the community by mitigating the disruption of neighborhood flight is a key component to addressing the effects of the recent foreclosure crisis. Despite this, given methodological and data limitations, the benefits of such programs are difficult to assess and are not reflected in our net benefits figures above.

Chapter 5. Transportation and Infrastructure

1. Introduction: Program Overview and Funding

Cook County and the City of Chicago received $692 million in America Recovery and Reinvestment (ARRA) funds for transportation and infrastructure projects.[47] Figure 1 and Table 1 summarize ARRA transportation and infrastructure funding by program. Annex 1, Chapter 5 in the Appendix has a more detailed breakdown of transportation and infrastructure funding by source. Due to a number of conflicting data streams, the total funding calculated was compiled based on only externally validated numbers.

Figure 1. Breakdown of ARRA funding by category. The City of Chicago received a total of $692 million of ARRA funding for transportation and infrastructure projects.



According to the Illinois Recovery Act database, road projects received the largest share of ARRA transportation and infrastructure funds. $269.6 million went to road projects, with road resurfacing projects receiving the greatest share of funds (State of Illinois 2011). The second largest share of ARRA funds went to the Chicago Transit Authority (CTA), which received $248.7 million for a variety of projects (City of Chicago 2011). Approximately, $90

[47] According to the Third Quarter 2010 Dashboard, a total of $499.6 million ARRA transportation and infrastructure funding had been awarded, and $312.2 million had been invested (62%). We believe that the programs included in this number are a subset of the programs we considered to be part of the ARRA funded transportation and infrastructure umbrella.

million of the funds were used for capital improvements to CTA facilities, as well as bus and rail infrastructure. Chicago committed $87.8 million to the Dearborn Subway track renewable project, which repaired nearly nine miles of track. Last, about $52 million of CTA funds were invested to purchase 58 new hybrid buses.

Table 1. Summary of ARRA transportation and infrastructure funding by project.

ARRA TRANSPORTATION & INFRASTRUCTURE FUNDING SUMMARY		
Aviation Improvement		
Chicago O'Hare Noise Mitigation	$	5,000,000
Chicago O'Hare Runway Rehab	$	12,294,387
Chicago/Rockford Renovations	$	4,672,000
Midway Cameras	$	2,734,418
Total	$	24,700,805
Water Maintenance		
Water Main Replacement	$	6,051,467
Sewer Replacement	$	10,000,000
Total	$	16,051,467
Highway Planning & Construction		
Street Lighting	$	2,191,967
Street Resurfacing	$	159,820,774
Traffic Signals	$	576,742
Highway Construction	$	90,552,887
Engineering	$	11,066,522
Other	$	5,406,433
Total	$	269,615,325
High Speed Rail Investment		
Total	$	133,000,000
CTA/Transit		
Dearborn Subway Track	$	87,800,000
Cermak/Chinatown Station	$	12,500,000
Hybrid Buses	$	51,500,000
CTA Maintenance	$	89,931,915
Other	$	6,944,528
Total	$	248,676,443
Grand Total =	**$**	**692,044,040**

Chicago dedicated $133 million of ARRA funds to an ongoing high speed rail project, though none of the funds have been obligated. Aviation projects received $24.7 million under the Airport improvement Program (FAA 2001) of which the largest funding share went to the Chicago O'Hare runway rehabilitation project. Last, water infrastructure projects such as water main and sewer improvements received $16 million (IEPA 2011).

The following literature review looks at the standard economic impacts in each of the transportation and infrastructure programs. We then present our estimates of the benefits of three ARRA funded transportation and infrastructure projects: the CTA purchase of 58 hybrid

buses, the Chicago O'Hare Runway Rehabilitation project, and the Dearborn Subway Renovation project. These cost-benefit analysis case studies were chosen in part by consistent reporting of awarded funding, available information and data, and measureable economic impacts.

2. Literature Review

2.1. Aviation

Chicago ARRA funds were channeled through the Federal Aviation Administration's Airport Improvement Program (FAA AIP) which provides grants to public and private agencies for public airports included in the National Plan of Integrated Airport Systems (City of Chicago (a) 2011). The grants target medium to large sized airports, and cover 75% of eligible project costs and 80% of noise mitigation project costs. The FAA prioritizes grants based on the National Priority Rating (NPR), which is scaled from 1-100, with a higher rating signifying greater priority. NPR thresholds are often overridden when projects address important state and local priorities, environmental issues, safety, airport growth and pavement conditions. A higher than usual NPR threshold[48] of greater than or equal to 62 was applied to ARRA projects. Despite the higher standard, only half of the ARRA aviation projects listed in Table 7.1 met the higher NPR criteria (FAA (a) 2011).

Most of the ARRA aviation funded projects were for capacity improvements. The FAA recommends large capacity projects when an airport approaches 60-75% of capacity. The evident impacts of capacity related projects are reductions in congestion and delay. The direct costs of delay are increased fuel costs and crew time, while the indirect costs include passenger travel time, air emissions and second order network delays (i.e. delay propagation multipliers) (Welman et. al. 2010). According to the Department of Transportation (DOT), a "delay" is considered to be a flight whose arrival or departure time exceeds 15 minutes. Among the 35 busiest U.S. airports contained in the Operational Evolution Plan, the average delay per operation is four minutes. Airport specific data is available via the Bureau Transportation Statistics.

In addition to capacity projects, Chicago used ARRA aviation funds for noise mitigation projects and safety enhancements. According to the FAA, efforts to reduce noise pollution provide an economic benefit to society. The benefits of noise mitigation are quantified in terms of physical units such as area, number of dwellings, and the population that is impacted (noise footprint). Then the before and after noise levels are considered. Sound measures include Day-Night Average Sound Level, which is the cumulative impact of noise (in decibels) over a 24 hours period. The FAA has an alternative model for noise abatement called the Area Equivalent Method, which estimates the size of a land mass impacted by a given noise. Lastly, FAA guidance on aviation cost-benefit analyses places significant weight on safety benefits; they

[48] As of 2005, discretionary grants require an NPR of 41. 85% of grants issues from 2005-2009 met that criteria.

recommend monetizing safety benefits in terms of the value of statistical life of reduced accidents and fatalities (Hoffer et. al. 1998; FAA (b) 2008).

2.2. Water

The City of Chicago falls within the Northeastern Illinois region, where Lake Michigan provides 68.8% of water resources (Chicago Metropolitan Agency for Planning 2010). The remainder of the region's water is supplied by groundwater (16.9%) and local rivers (14.3%). A 1967 U.S. Supreme Court decision placed a cap on Illinois' share of water from Lake Michigan. The diverted amount of water covered by the statute includes rainfall and storm water destined for Lake Michigan, whether or not it was captured, treated or consumed. 2005 water data shows that Illinois only diverted 85% of its water allowance, relative to 120% during the 1990's (Beyer-Clow et. al. 2009). In 2005, 60% of the diverted water was pumped for use, and 28% was lost as storm water runoff (U.S. Army Corps of Engineers 2005). Given that the water supply in the region is fixed, while demand is growing, strategic planning and management of water resources is essential.

The water management projects funded by ARRA reflect the critical goals of water infrastructure investment in Chicago: efficiency and conservation. Efficiency gains come from achieving the same level of output with less inputs into the system, whereas conservation attempts to reduce overall water consumption (Beecher 2010). Capital investments in water infrastructure help to reduce water loss or leakage in the system, which promotes efficiency. Chicago's water system has more than 8,000 miles of distribution pipes, 47,600 fire hydrants and 263,000 catch and value basins. Most of the water main system was installed between 1890-1940 are in need of repair. The City is looking to ramp up the replacement rate up to 75 miles per year, which is forecasted to save 40 million gallons of water a day by 2016 (Beecher 2010). Further, some studies consider infrastructure improvements with respect to land use. The intention is that more strategic decisions regarding development in the context of current water infrastructure capacity could help reduce the strain on current resources.

Sturm and Thorton (2011) contend that water loss control programs, which concentrate on water distribution, are a cost effective way to promote efficiency and conservation. In the realm of water control programs, costs are fairly easy to quantify, while benefits are more difficult, making cost effectiveness a more practical measure. Sturm and Thorton define cost effectiveness as the comparison of costs with its benefits, expressed in physical units (i.e. dollar per acre foot of savings). The authors recommend several interventions such as active leak detection, pressure management and district metering. Lastly, they provide data demonstrating cost differences between demand management strategies and distribution programs (water loss controls). The U.S. Environmental Protection Agency also has a comprehensive report on mitigating water losses related to drinking water systems (EPA (b) 2010).

2.3. Roads

There is a spatial mismatch between where people live and where they work. Compounding this is the uniformity of when people travel. The common adage of "working from nine to five" is more than just maxim, as it highlights the capacity shortage of traveling in America that manifests through traffic and congestion. One solution lies in a decrease in travel time through improvements in current infrastructure, such as ensuring high road quality and traffic control infrastructure.

Roads help to transport people between points, but not without its own deterioration. Deterioration is determined by two main factors: road quality and the level of traffic. Quality refers to the grade of pavement, the capacity design of the road (whether suburban or highway), and the vertical and horizontal set of the road that predicts how environmental conditions will cause road fractures (Archondo-Callao 2011). Traffic volume, including weight, average speed and presence of pedestrians, all affect how pressure is applied to the road and how it will degrade over time (TX DOT 2010). Deterioration of roads results in slower traffic and increased travel time, which can be monetized as an opportunity cost. The addition of more roads also encourages more traffic through an increase in road capacity; the increased flow of traffic causes congestion, in turn resulting in economic and environmental consequences (Gazis 2002).

2.4. Rail

A popular method of transit infrastructure is high speed rail. Compared to bus transportation systems, rail is more expensive to both construct and operate. However, it is generally more successful in attracting new passengers, and is more efficient in situations with high levels of ridership.[5] Furthermore, rail produces denser development around connection nodes that result in more environmentally friendly land development (Todorovich et. al. 2011). As of February 2011, the federal government has begun the initial stages of intercity (or city to city) high-speed rail. The proposal includes connecting Chicago to six neighboring cities, Detroit, St. Louis, the Twin Cities, Kansas City and Iowa City, with possible extensions to Oklahoma City and Omaha (FRA 2011). It is relevant to note that this design is not to boost exurban commuters, but to re-invigorate national train travel and encourage greater bonds between these cities.

In a case study of Amtrak in Texas, 77% of all trips concluded out of state (Morgan et. al. 2009), indicating the train's viability as a mode of travel. Chicago's central location makes it a hub for most modes of transit, and making it the hub of a Midwest high-speed rail network is not surprising. However, there is no available public ridership forecast, only quantifications of Chicago's travel market (Todorovich et.al. 2011). There are millions of travelers who ferry between Chicago and their destinations, but very little concrete evidence that they would take rail rather than their current mode of transportation.

2.5. Transit

Aside from road expansion, augmenting traffic volume and reducing congestion can be tackled by expansion of public transit. Transit systems can increase efficiency by reducing traffic and congestion (as fewer people will be driving personal vehicles) resulting in lower levels of particulate matter (PM) emissions. High levels of PM emissions are highly correlated with severe complications of the heart and lungs, especially for children under eighteen and those over sixty-five (EPA (c) 2011). These particles can cause cancer and at the most extreme, premature death (EPA (d) 2003). Diesel hybrid buses with the federally mandated filters produce less PM emissions then normal diesel buses (San Francisco MTA 2011).

The federal government provides partial funding for environmentally-friendly, public transport, so long as projects meet public transit design requirements. The criteria include six cost effective measures: 1) incremental cost per hour of transportation system user benefit; 2) transit and mobility performance measured by user benefits per passenger mile; 3) number of transit dependents using the project; 4) transit dependent user benefits per passenger mile; 5) share of user benefits received by transit dependents compared to share of transit dependents in the region and 6) environmental benefits measured in air quality (DOT 2010). The DOT is currently reviewing its metrics to widen the scope of measured benefits, but this review is still on-going and currently not publicly available (FTA 2010).

In the absence of revised federal criteria, many municipalities and organizations have developed techniques to quantify these transit design metrics. Often a travel demand forecast is conducted; a travel demand predicts the estimated ridership levels during peak hours, and also compares traffic flow between a forecast with the system against a baseline without the system, using an input output model (Blonn 2006; Litman 2011). A number of reports relied on the metrics cost of carbon dioxide emissions and cost of traveling. The most common metric was vehicle miles traveled (VMT), which measures the number of cars traveling on an average day. VMT figures are then extrapolated to determine crash and fatalities statistics and traffic density (EIA 2002).

Based on the reviewed literature, we have derived a set of economic impact measures for each transportation and infrastructure ARRA funding category. Table 2.1 summarizes our recommendations.

Table 2.1. Summary of literature review

Summary of Literature Review for ARRA funded projects in Chicago		
Source	**Impact Measure**	**ARRA CBA**
Aviation	Capacity improvement	Runway rehabilitation & terminal expansion: delay reduction
	Noise mitigation	Reduction in noise footprint
	Safety	Midway cameras: increased security and reduced fatalities
Water	Conservation & Efficiency	Water mains: increased water flow due to population growth Sewer: reduced leakage per gallon through sewage system
Roads	Mobility	Street resurfacing, traffic signals, highway engineering & construction: improved travel time, less emissions, congestion cost decline
Rail	Capacity increase	Building high speed rail: reduced price for interstate travel, reduced pressure on other transportation modes
	Economic development	Economic growth of adjacent areas
Transit	Capacity improvement	Improved ridership, increased revenue
	Congestion reduction	Reduction in congestion measured by travel time cost savings

3. CBA: Purchase of Hybrid Buses

3.1. Introduction

In 2009, the CTA committed $51.5 million of ARRA funds to purchase 58 60-foot 4000-Series New Flyer Hybrid Buses.[49] The hybrid buses arrived in the fall of 2009. This analysis focuses on monetizing the four key benefits of the new hybrid buses:

1) Fuel cost savings: Transportation agencies perpetually struggle with increasing fuel costs. According to the 2011 CTA Budget, fuel costs represent 4.6% ($58 million) of the total 2010 operating budget (CTA 2011). Research indicates that hybrid buses offer a 28-48% increase in fuel economy which makes them attractive to the CTA (EESI 2007).

[49] The Chicago ARRA data cites $51.5 million for 52 buses meanwhile other sources reference $49 million for 58 buses. We confirmed that 58 buses were purchased and delivered.

2) Environmental and climate change benefits: Fuel consumption savings translate into environmental and climate change benefits from the reduction in diesel emissions and greenhouse gases.
3) Health Benefits: The reduction in particulate matter (PM) emissions reduces the risk of negative health outcomes. A study conducted by the World Health Organization reveals that at 10 PPM, there is a 6% increase in risk of PM related deaths (WHO 2005).
4) Maintenance cost savings: In general, hybrid buses are cheaper to maintain than the conventional diesel buses given the reduced stress on brakes and electric drive, requiring fewer repairs than regular transmission buses. The CTA estimates that the hybrid bus technology will save the agency nearly $2.3 million annually in maintenance, parts and labor costs over the current bus fleet in service (CTA 2009).

The calculated total net present value also includes the ARRA grant for the purchase of hybrid buses. Since the CTA is continuously replacing its bus fleet with hybrid buses, without ARRA funding, the purchase of additional buses would have otherwise transpired in a short time horizon. The ARRA grant was essentially a "free gift" to the CTA and included in the total monetized benefit.

3.2. Methodology & Results

According to the CTA's Presentation on Alternative Fuels (2009), prior to the arrival of the ARRA funded hybrid buses, the CTA bus fleet consisted of 2024 buses. With the addition of the 58 new hybrid buses, we assumed the bus fleet grew to 2082 buses, with no additional buses being added or retired from the fleet. For our baseline counterfactual, we assumed that without ARRA funding, 58 new diesel buses would have been purchased and added to the fleet, with no additional buses being added or retired from the fleet. In our sensitivity analysis we address a number of alternative counterfactuals, including the case when diesel buses are retired and capacity is reduced. Table 3.2.1 summarizes the CTA bus capacity at the end of 2009.

Table 3.2.1. Inventory of 2009 CTA bus fleet under ARRA funded (addition of 58 new hybrid buses) and counterfactual (addition of 58 new diesel buses) scenarios.

BUS TYPE	MODEL	COUNTERFACTUAL: FLEET WITH 58 NEW DIESEL BUSES	ARRA FUNDING: FLEET WITH 58 NEW HYBRID BUSES	MPG BUS
30 ft Diesel	500 Series Optima Opus	45	45	3.300
40 ft Diesel	6000-series Flxible Metro	299	299	3.375
40 ft Diesel	6400-series NOVA Bus LFS	480	480	3.375
40 ft Diesel	1000-series New Flyer D40LF	1088	1030	3.280
40 ft Hybrid	800-series New Flyer DE40LF	10	10	3.650
40 ft Hybrid	900-series New Flyer DE40LF	10	10	3.650
60 ft Hybrid	4000-series New Flyer DE60LF	150	208	3.700
	Total 2009 CTA bus fleet =	2082	2082	

Figure 3.2.1. Outline of ARRA funded hybrid bus benefit calculations.

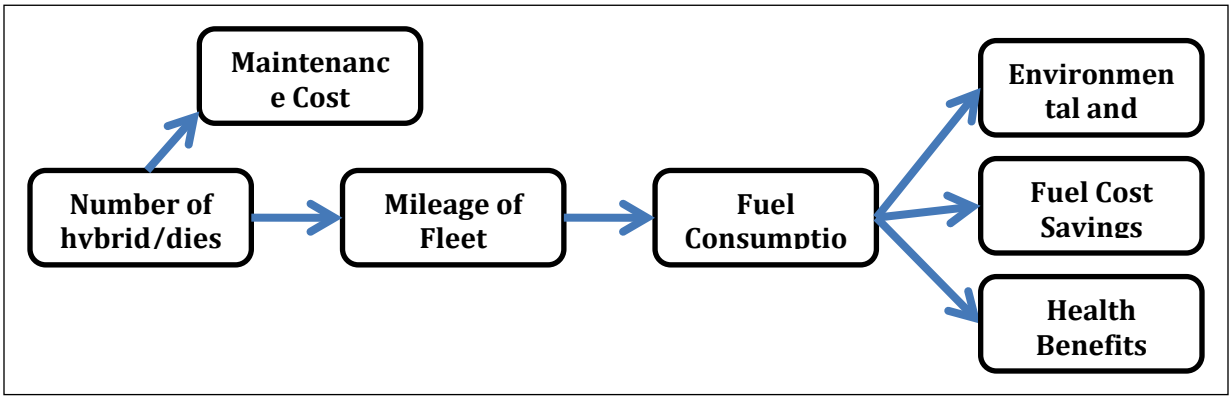


Figure 3.2.1 outlines our methodology in calculating the benefits from the ARRA funded hybrid buses. Under the ARRA funded and counterfactual scenarios, and from the diesel and hybrid bus capacity, we estimate CTA bus fleet mileage and then fuel consumption. We use the difference in fuel consumption between the two scenarios to estimate the expected benefits from the hybrid buses.

In addition, we made the following baseline assumptions:

- The lifetime of a hybrid bus is 15 years. The ARRA funded hybrid buses became operational at the end of the 2009, we calculate the lifetime of the hybrid bus from 2009-2023.
- During this time frame, there is no change in ridership demand, nor change in bus route or route frequency (fleet mileage is constant).
- Each bus (regardless of its fuel economy) drives the same number of miles per year.
- The City of Chicago diesel fuel contract price stays constant at $3.49/gallon.[50]

According to the CTA's Presentation on Alternative Fuels, prior to ARRA funding, the average weekday miles for the CTA bus fleet was approximately 220,000 system miles per day. Using the CTA Annual Ridership Report's (2011) percentage of weekday and weekend passenger boardings, we extrapolate this number and estimate that the CTA bus fleet drove a total of 69,110,089 miles per year. This equates to 34,145 miles per year per bus. With the addition of the 58 new buses, holding miles/year per bus constant, this equates to 71,090,516 system miles.

[50] The City of Chicago diesel fuel contract price expires in September 2013. We assume the contract does not expire for the 15 year hybrid bus lifetime. In our sensitivity analysis we assume an increase in diesel fuel prices.

Fuel Cost Savings:[51]

From total fleet miles calculated, we determined the percent share of miles per bus. For example, according to Table 3.2.1, under the ARRA funding scenario there are a total of 208 60-foot hybrid buses, and under the counterfactual there are 150 60-foot hybrid buses. Since there are a total of 2082 buses, the percent share of the 60-foot hybrid buses from the ARRA funded scenario is 9.99%, while in the counterfactual it is 7.20%.

Since we assumed that each bus drives the same number of miles per year, using the estimated 71,090,516 miles per year for the CTA bus fleet, for each of the 60-foot hybrid bus fleets, we can then determine the number of miles per year for the ARRA funded and counterfactual scenarios. From miles per year, using the buses' fuel economy from Table 3.2.1, we calculated the difference in fuel consumption, in gallons per year, between the ARRA funded hybrid buses and the counterfactual. Based on the $3.49 per gallon diesel price, we then calculate fuel cost savings per year.

Table 3.2.2 summarizes the differences in fuel consumption for the various types of CTA buses. After summing up the difference in fuel costs per year for each type of bus, we determined the total discounted fuel cost savings over the fleet's 15 year lifetime, at a 3.2% discount rate. Overall, the total discounted fuel cost savings from the ARRA funded hybrid buses is **$2,904,729**.

[51] Detailed fuel cost, environmental and health benefit example calculations are located in Chapter 5, Section 2 of the Appendix.

Table 3.2.2: Summary of fuel cost savings between the ARRA funded 58 new hybrid buses, and counterfactual of 58 new diesel buses.

BUS TYPE	PERCENT SHARE OF FLEET		MILES PER YEAR		GALLLONS/YEAR		DIFFERENCE IN	FUEL COST/YEAR		DIFFERENCE IN FUEL
	58 DIESEL BUSES	58 HYBRID BUSES	58 DIESEL BUSES	58 HYBRID BUSES	58 DIESEL BUSES	58 HYBRID BUSES	GALLONS/YEAR	58 DIESEL BUSES	58 HYBRID BUSES	COST/YEAR
30 ft Diesel	2.16%	2.16%	1,536,539	1,536,539	465,618	465,618	0	$1,625,006	$1,625,006	$0
40 ft Diesel	14.36%	14.36%	10,209,445	10,209,445	3,025,021	3,025,021	0	$10,557,322	$10,557,322	$0
40 ft Diesel	23.05%	23.05%	16,389,744	16,389,744	4,856,221	4,856,221	0	$16,948,210	$16,948,210	$0
40 ft Diesel	52.26%	49.47%	37,150,087	35,169,660	11,326,246	10,722,457	603,789	$39,528,599	$37,421,376	$2,107,223
40 ft Hybrid	0.48%	0.48%	341,453	341,453	93,549	93,549	0	$326,485	$326,485	$0
40 ft Hybrid	0.48%	0.48%	341,453	341,453	93,549	93,549	0	$326,485	$326,485	$0
60 ft Hybrid	7.20%	9.99%	5,121,795	7,102,223	1,384,269	1,919,520	-535251	$4,831,099	$6,699,123	-$1,868,025
Total			71,090,516	71,090,516	21,244,472	21,175,933	68,538	$74,143,206	$73,904,007	$239,198
									Discounted fuel cost savings for 15 years with a 3.2% discount rate =	$2,904,729

Environmental and Climate Change Benefits:

In order to calculate the environmental and climate change benefits from the ARRA funded 58 hybrid buses, we make the following assumptions in Table 3.2.3:

Table 3.2.3. Summary of emissions per gallon diesel and emission price assumptions. Source for emissions (lbs/gallon): Hill (1996)

	EMISSIONS (lbs/gallon diesel	PRICE ($/short tons)	EMISSION PRICE SOURCE
CO2	2.22	$7.25, $23.59, $77.11	$23.59: weighted-average global carbon price estimate (Point Carbon 2011). For sensitivity analysis we used $7.26 (Nordhaus 2007) and $77.11 (Stern 2007)
NOX	0.00256	$750	Estimated average price for NOx (EPA 2009) price trends 2005-2009. While we believe these prices reflect environmental externalities (ozone formation) in addition, we assume this value accurately portrays the price of climate externalities.
SOX	0.000371	$500	Estimated average price for SOx (EPA 2009) price trends 2005-2008. While we believe these prices reflect environmental externalities (acid rain), in addition, we assume this value accurately portrays the price of climate externalities.
PM10	0.00111	NA	

From Table 3.2.2, the total difference in diesel fuel saved between the ARRA funded hybrid buses and the counterfactual is 68,538 gallons per year. Using this value, we calculated the yearly savings in fleet emission output for CO_2, NO_x and SO_x summarized in Table 3.2.4. Total emissions saved per year, from the ARRA funded hybrid buses is $1866.58 per year. Therefore, the total discounted emission cost savings over the fleet's 15 year lifetime, at a 3.2% discount rate, **$22,667**. Using the low and high carbon price, the total discounted environmental and climate change benefits from the ARRA funded hybrid buses range from $7,574 - $72,114.

Table 3.2.4 Summary of emission cost savings per year, based on the baseline scenario of 68,538 gallons diesel saved per year.

(based on 68,538 gallons diesel saved/year)		
	emissions saved/year (lbs)	***savings ($/year)***
CO2	152,154.79	$1,794.42
NOX	175.46	$65.80
SOX	25.43	$6.36
Total emissions savings/year =		$1,866.58
Total discounted lifetime emissions savings =		$22,666.96

Health Benefits:

In order to estimate health benefits from the ARRA funded hybrid buses, we first estimate the number of premature deaths in Cook County due to PM emissions. There are an estimated 15,000 premature deaths per year in the U.S. due to PM emissions (Esworthy 2006). Based on the 2010 U.S. population of 309,000,000 (Census Bureau 2010) and 2009 Cook County population of 5,287,037 (Census Bureau 2010), we pro-rate the number of premature deaths due to PM to 256.65 people per year in Cook County.

In Table 3.2.5, based on the difference in fuel consumption per year from the ARRA funded hybrid buses and the counterfactual, we determined a 0.32% percent reduction per year of PM emissions. We can now estimate the impact of premature deaths in Cook County; a 0.32% reduction in the number of premature deaths in Cook County results in 0.8307 fewer deaths per year. Based on Viscusi (2003), we use $8,442,000 as the value of a statistical life to monetize the PM reduction benefits from the hybrid buses. Overall, the total discounted health benefits of the ARRA funded hybrid buses, over a 15 year lifetime, at a 3.2% discount rate, is **$89,530,574**.

Table 3.2.5. Summary of health benefits per year, based on 256.65 premature deaths due to PM per year in Cook County

Scenario	***Gallons consumed/year***	***PM 10 (lbs/year)***
ARRA Funding	21,244,472	23,581
Counterfactual	21,175,933	23,505
% Change PM from ARRA funding =		0.32%
Reduction in premature deaths in Cook County =		**0.8307 people/year**

Maintenance Cost Savings:

To estimate maintenance cost savings from the hybrid buses, we examined CTA fleet maintenance cost budget data from 2002 – 2006 (CTA (c-g)). We selected this time period for two reasons. First, CTA purchased their first hybrid buses in late 2006; hence, the maintenance cost data from 2007 and later would contain a fleet mix of diesel and hybrid buses. Second, CTA

reported its budget in a consistent format over this period. Using CTA budget information on garage and heavy maintenance for its bus fleet, we derived an annually increasing maintenance cost per diesel bus, and averaged out this rate over 15 years. This resulted is a 2.5% annual increase in fleet maintenance costs.

To predict the increase in fleet maintenance costs through 2023, we use 2005 as our baseline year. The CTA budget reports maintenance values from five years back (i.e. 2010 budget report includes data for 2005 – 2010) (CTA (h) 2010). One concern is that the CTA budget reporting lacks consistency; maintenance data in the 2010 budget report do not match reported maintenance costs in the 2005 budget report. As a compromise, we use a 2005 maintenance expense per diesel bus ($78,767) from the 2010 budget report, to derive increasing maintenance costs (2.5% yearly growth) for the 15 years lifespan of a hybrid bus.

An Environmental and Energy Institute study (2007) reported that the operational cost for hybrid buses is 15% lower than for diesel buses, based on a year-long evaluation of New York's hybrid bus fleet. However, since hybrid buses were recently introduced on a wide scale to the public transit market, information regarding its actual maintenance cost savings over a significant time period is limited, and varies by the bus manufacturer; we address this concern in our sensitivity analysis. In sum, the total discounted maintenance cost savings from the ARRA funded hybrid buses, over the fleet's 15 year lifetime, at a 3.2% discount rate, is **$10,944,612**.

Table 3.2.6 summarizes the total discounted benefits of the ARRA funded hybrid buses. The impact of fuel cost savings, environmental and climate change benefits, health benefits, and maintenance cost savings sum up to $103,402,582 (using the low and high carbon price, this total benefit ranges from $103,387,496 to $103,452,030). With the addition of the ARRA grant, the total benefit of the hybrid buses is **$154,902,582**.

Table 3.2.6: Summary baseline results, assuming a counterfactual of 58 new diesel buses purchased, and no change in passenger demand, diesel price or fleet capacity.

HYBRID BUS BASELINE CBA SUMMARY	
	CO2 $23.59/short ton
Fuel Cost Savings	$2,904,729
Environmental Benefits	$22,667
Health Benefits	$89,530,574
Maintenance Cost Savings	$10,944,612
Total =	$103,402,582
ARRA grant	$51,500,000
Total NPV	**$154,902,582**

Sensitivity analysis

In our baseline scenario, we assumed that without ARRA funding, the city would instead purchase 58 new diesel buses. We also hold constant diesel price and passenger demand over

the lifetime of the hybrid bus. The baseline scenario fails to take into account the changing state and age of the CTA bus fleet. For example, in 2009 many of the 40 foot Diesel 6000-Series Flexible Metro buses had exceeded their life expectancy and were due to be retired. Further, according to the 2010 budget recommendations, the CTA is pushing to eventually replace its entire fleet with hybrid buses (CTA (h) 2010). Any change in bus capacity or bus route will shift the stress of each individual bus; for example, lost capacity can mean that each bus has to drive more miles per day, or that routes are modified such that fleet miles per day stays constant.

In our sensitivity analysis we test 22 alternative scenarios which impact fuel cost savings, environmental and climate cost savings, health benefits and maintenance cost savings. First, we assumed that fleet mileage would stay constant, increase or decrease. Then, under these three categories, we examined different sets of parameter assumptions for capacity, passenger demand, diesel prices and maintenance cost as listed in Table 3.2.7. Since we vary two variables at a time, we can not necessarily discern trends across categories (i.e. we cannot directly compare benefits from a scenario with an increase in miles from an increase in passenger demand, to a scenario with no change in miles from constant passenger demand). By comparing benefits derived by changing each variable, *ceteris paribus*, we found that in general, an increase in passenger demand, bus capacity, diesel prices or maintenance cost savings resulted in an increase in hybrid bus benefits.

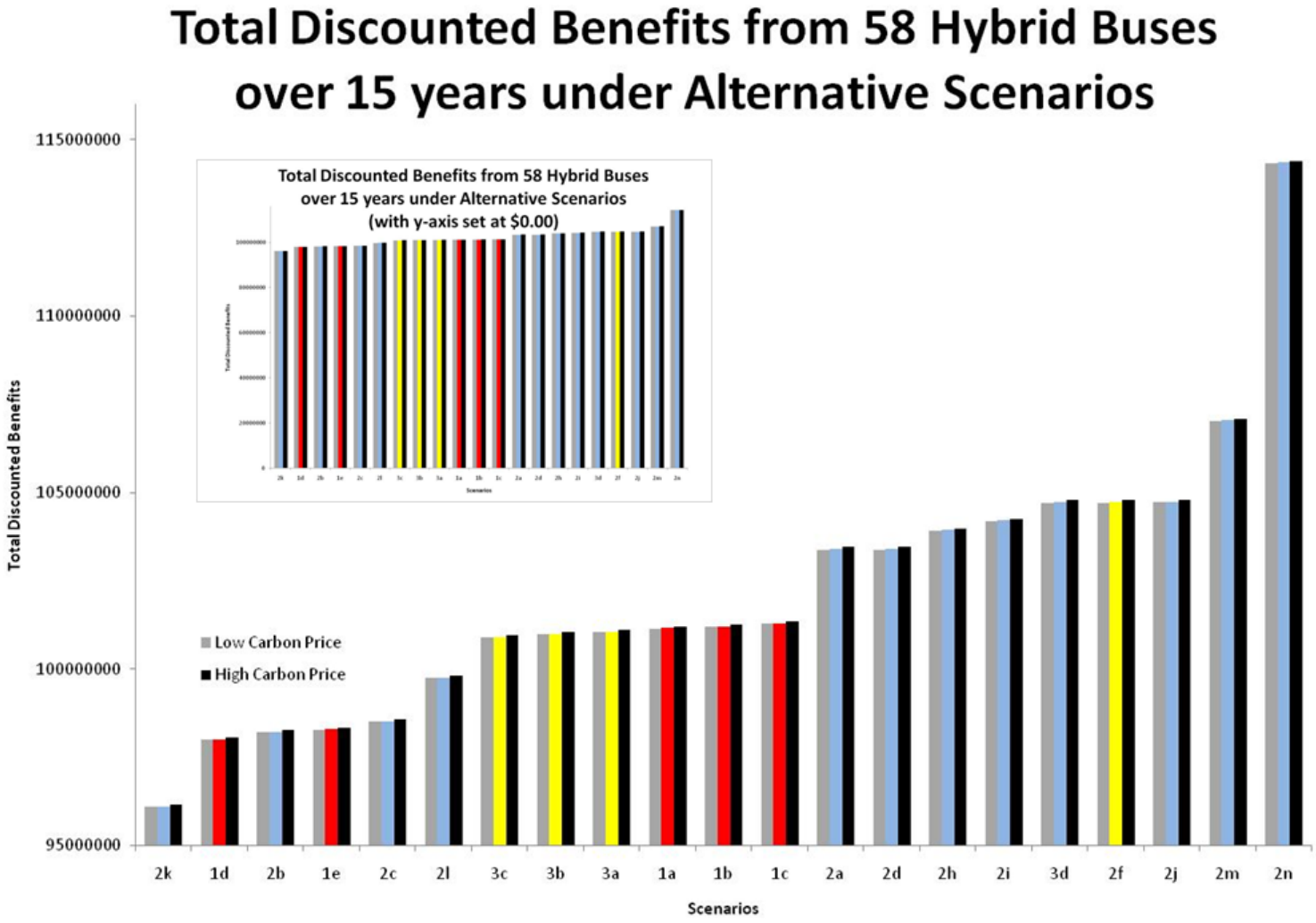
When fleet mileage increases, through an addition of 12 buses per year, benefits decreased by approximately $5 million (1d-e). In contrast if mileage increased due to a growing passenger demand (3.5 – 14% increase over 15 years), benefits decreased by approximately 2% (1a-c). Scenarios decreasing fleet mileage mirror the scenarios increasing fleet mileage. We found that a decrease in capacity results in a 1.3% decrease in benefits (3d), while a reduction in passenger demand lowers benefits on average by 2% (3a-c). When fleet mileage remains constant, benefits increased if CTA continues to retire its old diesel buses (2f); this is consistent with the fact that retirement of one diesel bus impacts all benefit categories except for maintenance cost savings. In addition, an increase in diesel prices yields benefits between $101 and $102 million (2h-j). Last, the variation in benefits from the various maintenance cost savings scenarios range from -7% to 9% (2k-n); this is important to note due to the age of hybrid technology.

The selected scenarios were chosen to capture realistic situations that the CTA could be faced with. Figure 3.2.2 and Annex 2, Chapter 5 in the Appendix, shows that the benefits from the ARRA funded hybrid buses, in the alternative scenarios, ranged from $96,106,173 to $114,347,193. Benefits fluctuated between -7% to 9% of the baseline scenario, demonstrating the robustness of our analysis. Overall, even with uncertainty regarding the future development of CTA public transit, there were substantial benefits in purchasing the hybrid buses.

Table 3.2.7. Summary of sensitivity analysis alternative scenarios. Scenario (2a) is the original baseline scenario.

SENSATIVITY ANALYSIS PARAMETERS			
INCREASE IN MILES	1a	passenger demand increases	0.25%/year (3.5% over 15 years)
	1b		0.5%/year (7% over 15 years)
	1c		1%/year (14% over 15 years)
	1d	increase buses (12 additional buses/year)	increase number of diesel buses
	1e		increase number of hybrid buses
NO CHANGE IN MILES	2a	passenger demand remains constant	
	2b	increase buses (12 additional buses/year)	increase number of diesel buses
	2c		increase number of hybrid buses
	2d	no buses retire/replaced	
	2f	decrease diesel buses (12 buses retired/year)	
	2h	diesel prices increases	$0.10/year ($1.50 over 15 years)
	2i		$0.15/year ($2.25 over 15 years)
	2j		$0.25/year ($3.75 over 15 years)
	2k	maintenance cost savings decrease/increase	maintenance cost savings 5%/hybrid bus
	2l		maintenance cost savings 10%/ hybrid bus
	2m		maintenance cost savings 20%/hybrid bus
	2n		maintenance cost savings 30%/hybrid bus
DECREASE IN MILES	3a	passenger demand decreases	0.25%/year (3.5% over 15 years)
	3b		0.5%/year (7% over 15 years)
	3c		1%/year (14% over 15 years)
	3d	decrease diesel buses (12 buses retired/year)	

Figure 3.2.2. Total discounted benefits by scenario. The colored estimates calculate benefits with a carbon price at $23.59/short tons. Red = increase in miles, blue = no change in miles, yellow = decrease in miles. The grey and black estimate total benefits from a low and high carbon price. Scenario (2a) is the original baseline scenario.



4. CBA: O'Hare Runway and Taxiway Rehabilitation

4.1. Introduction

In 2009, the City of Chicago received $12.2 million in ARRA stimulus money to rehabilitate the runway at Chicago O'Hare International Airport. The grant was awarded by the Federal Aviation Administration (FAA) as a first competitive grant funded by ARRA. The stimulus money was used to replace concrete pavement on runway 10/28 and to widen and relocate Taxiway M, which is parallel to runway 10/28. This project was completed at the beginning of 2010 (City of Chicago (b) 2009).

O'Hare is one of the busiest airports in the nation. Given the limited capacity and growing passenger demand, O'Hare has consistently ranked as having one of the highest delays in the U.S. The $6.6 billion O'Hare modernization plan, approved by FAA in 2005, aims to reduce delays by 80%, and increase airport capacity by 60% through additional terminal space and airfield reconfiguration. As part of the airfield reconfiguration, extensive work is being done on runway 10/28 (FAA 2005). For the purpose of this cost-benefit analysis, we consider the ARRA funded O'Hare runway rehabilitation project as a part of the modernization plan; given the ongoing work on runway 10/28, it is impossible to derive individual benefits without taking into account the big picture of O'Hare renovations.

The O'Hare modernization plan incorporates detailed modeling of future passenger and airline demand, and estimates airport delays with and without renovations. Based on FAA Airport Benefit-Cost Analysis Guidance (1999), the standard benefit for runway and taxiway reconstruction projects is the "avoided loss of capacity benefits associated with facility failure." Increased capacity results in reduced delays at the airport; this CBA considers delay reduction as the most significant project benefit.

4.2. Methodology & Results

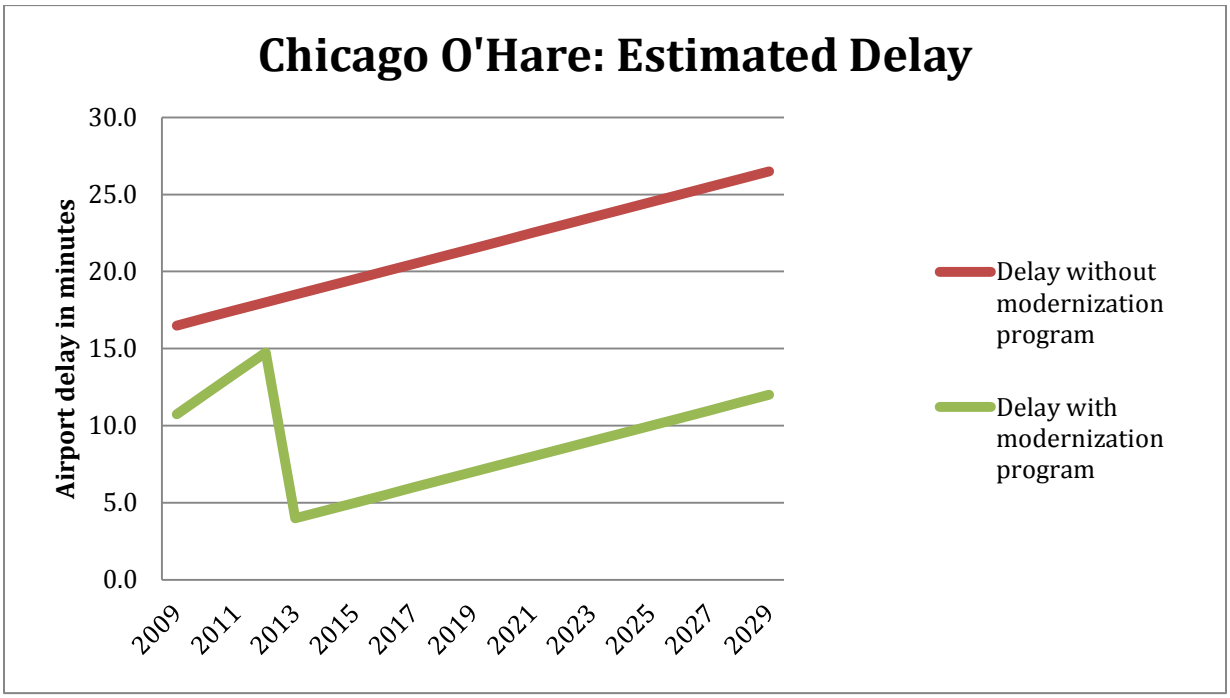
Airport delays are calculated by comparing airport capacity with airport demand. The monetized average cost of delays includes direct costs (such as crew, fuel and oil), total maintenance costs, and indirect cost (such as passenger time). According to the Department of Transportation, a flight is considered delayed if its arrival or departure time exceeds 15 minutes of its scheduled time. The O'Hare Modernization Program Business Case (2005) estimates that for "every additional minute of average annual delay [it] equates to roughly $20 - 40 million" in passenger costs. Using the average of these two estimates and available O'Hare delay data, we estimate time cost savings associated with the reduction in delay from the ARRA funded runway and taxiway rehabilitation project.

The following assumptions were made:

- The counterfactual is that the O'Hare modernization project would not have occurred.
- Without the modernization plan, there will be no reduction in delays; thus benefits are derived through the modernization plan.
- The ARRA funded portion of the project was utilized at the end of 2009, resulting in benefits starting in 2009.
- Runway rehabilitation (replacement of concrete pavement) prolongs runway life by 20 years (Eugene Airport 2010); benefits for this project will accrue until 2030.
- The modernization project is scalable. The entire project is expected to reduce airport delays; thus the ARRA funded portion would be expected to reduce delays by:
  ($ARRA grant/total cost of modernization project) * (total reduction in delays)

Figure 4.2.1 shows the forecasted delay development with and without the O'Hare modernization plan. The O'Hare Modernization Program Business Case forecast delay developments up to 2016. Since airport demand is expected to increase linearly by 3% per year, and the modernization plan increases airport capacity by 60%, we estimate steady growth in delays for both the ARRA funded and counterfactual scenarios.

Figure 4.2.1. Projected delay time at Chicago O'Hare Airport with and without the modernization project.



The total benefit of the O'Hara modernization plan was calculated as follows:

$$\text{yearly total benefit} = (\text{delay without modernization plan in period t} - \text{delay with modernization plan in period t}) * \$30 \text{ million cost}$$

$$\text{ratio for scaling down benefits} = \frac{\text{ARRA Funding}}{(\text{total cost of modernization plan} + \text{ARRA funding})} = 0.18\%$$

Table 4.2.1. Yearly benefits of ARRA funded O'Hare Runway and Taxiway rehabilitation project

ARRA FUNDED O'HARE RUNWAY AND TAXIWAY REHABILITATION PROJECT					rescaling factor = 0.00186
Year	Delay without modernization program	Delay with modernization program	Decrease in delay	Total Benefits for O'Hare Modernization	Discounted re-scaled benefit of runway and taxiway rehab
2009	16.5	10.8	5.75	$172,500,000	$321,331
2010	17.0	12.1	4.92	$142,926,357	$266,241
2011	17.5	13.4	4.08	$115,020,882	$214,259
2012	18.0	14.8	3.25	$88,708,559	$165,245
2013	18.5	4.0	14.5	$383,504,503	$714,387
2014	19.0	4.5	14.5	$371,612,891	$692,235
2015	19.5	5.0	14.5	$360,090,010	$670,771
2016	20.0	5.5	14.5	$348,924,429	$649,972
2017	20.5	6.0	14.5	$338,105,066	$629,817
2018	21.0	6.5	14.5	$327,621,188	$610,288
2019	21.5	7.0	14.5	$317,462,392	$591,364
2020	22.0	7.5	14.5	$307,618,597	$573,028
2021	22.5	8.0	14.5	$298,080,036	$555,259
2022	23.0	8.5	14.5	$288,837,244	$538,042
2023	23.5	9.0	14.5	$279,881,050	$521,358
2024	24.0	9.5	14.5	$271,202,568	$505,192
2025	24.5	10.0	14.5	$262,793,186	$489,527
2026	25.0	10.5	14.5	$254,644,560	$474,348
2027	25.5	11.0	14.5	$246,748,605	$459,640
2028	26.0	11.5	14.5	$239,097,485	$445,387
2029	26.5	12.0	14.5	$231,683,610	$431,577
Total Benefit =					**$10,519,270**

Table 4.2.1 shows the yearly benefits from delay reductions. The total discounted benefits, derived from the runway and taxiway rehabilitation, over the prolonged 20 year lifetime, at a 3.2% discount rate is $10,519, 270. Similar to the purchase of the hybrid buses, the ARRA grant towards the O'Hare modernization project ($12,294,387) is considered a free

monetary gift to O'Hare and included as a benefit in the analysis. Overall, the total benefits derived from the ARRA funded runway rehabilitation project is **$22,813,657**.

This cost-benefit analysis uses delay and cost data as reported in the O'Hare Modernization Program Business Case to ensure consistency in our analysis. The following sensitivity analysis addresses scenarios in which values reported in the O'Hare Modernization Program Business Case were over or underestimated. In particular, we examine eight different scenarios for delay development, and examine a lower and upper bound in delay costs ($20 and $40 million).

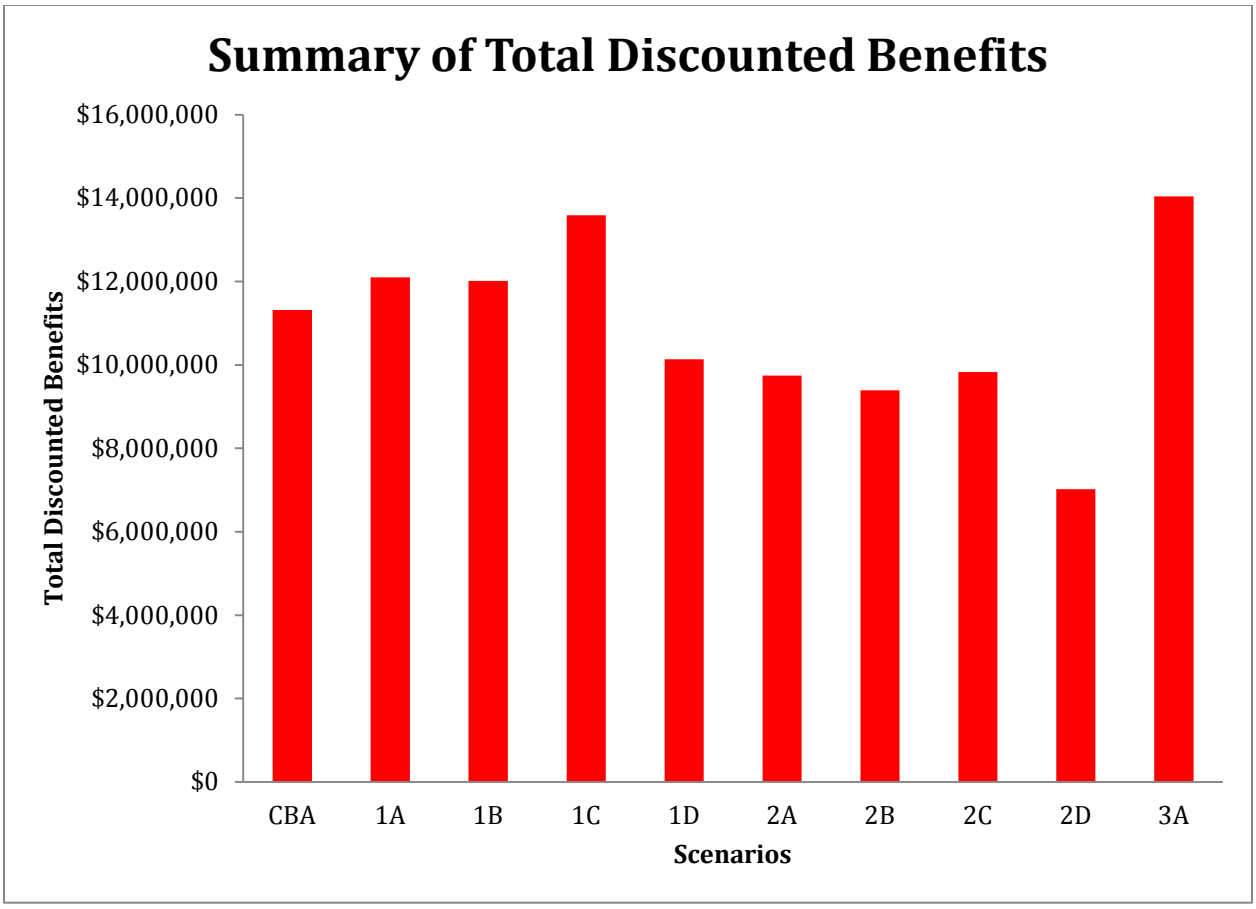
In scenarios 1 and 2 of the sensitivity analysis, the change in delays are based on the assumption that the baseline scenario (no modernization plan) can be influenced by external shocks such as the economic crisis, an increase in fuel costs, or an increase in competition. We suppose that the demand forecast can vary substantially from our baseline scenario. The results, summarized in Table 4.2.2 and Figure 4.2.2, show that delay reduction benefits increase by almost 1/3 when passenger demand is greatly underestimated (1d). On the other hand, a decrease in delays of up to one minute, when passenger demand is overestimated, decreases benefits by $750,000 (2b).

The cost of a one minute of delay can also vary substantially given the different valuations of passenger time. For example, if the majority of passengers are traveling for leisure, resulting in a lower valuation of time, the cost of a one minute of delay reduces by 1/3, resulting in a 33% decrease in benefits (3a). In contrast, if the majority of passengers are traveling for business, this will raise the cost of a one minute delay by up to $14 million in benefits.

Table 4.2.2. Summary of yearly benefits of ARRA funded O'Hare Runway and Taxiway rehabilitation project based on an increase and decrease in delay time, and over and underestimate of delay costs.

SCENARIO		BENEFIT FROM DELAY REDUCTION
CBA	forecasted yearly delay	**$10,519,270**
1	INCREASE IN DELAY (PASSENGER DEMAND UNDERESTIMATED)	
1a	increase by 1 additional minute (only baseline)	**$11,314,432**
1b	increase by 2 additional minutes (only baseline)	**$12,099,445**
1c	increase by 3 additional minutes (baseline), 1 minute with modernization	**$12,017,363**
1d	increase by 5 additional minutes (baseline), 1 minute with modernization	**$13,587,388**
2	DECREASE IN DELAY (PASSENGER DEMAND OVERESTIMATED)	
2a	decrease by 0.5 additional minute (only baseline)	**$10,136,913**
2b	decrease by 1 additional minute (only baseline)	**$9,744,407**
2c	decrease by 2 additional minutes (baseline), 0.5 minutes with modernization	**$9,392,942**
2d	decrease by 2 additional minutes (baseline), 1 minute with modernization	**$9,826,490**
3	OVER/UNDERESTIMATION OF DELAY COST	
3a	delay cost of 1 minute = $20M	**$7,019,613**
3b	delay cost of 1 minute = $40M	**$14,039,226**

Figure 4.2.2. Summary of yearly benefits of ARRA funded O'Hare Runway and Taxiway rehabilitation project based on an increase and decrease in delay time, and over and underestimate of delay costs.



5. CBA: Dearborn Subway

5.1. Introduction

The Dearborn Subway covers 8.67 miles of blue line track from Division to UIC-Halsted, including part of the Loop. Originally constructed in the 1950s, by 2009 rail had deteriorated to the extent that 6.8% of the Dearborn Subway were considered slow zones, with some areas restricting rail speed to as low as 6 mph (City of Chicago 2010). In March 2009, 3.39% of track was limited to rail speeds less than 15 mph and 3.62% of track was limited to rail speeds between 15 – 25 mph, in comparison to the normal speeds of up to 55 mph.

$87.8 million of ARRA funds were granted for the Dearborn Subway track replacement. Renovations began in April 2009, with Phase I and II focused on replacing track between Division and Grand, and Phase III focused on track between Clark/Lake and UIC-Halsted. By the end of 2009 year (9 months later) all slow zones had been eliminated (City of Chicago 2010).

The Dearborn Subway track renewal project was a "shovel-ready" project; when ARRA funding was announced, it became one of the first Chicago transportation and infrastructure projects to receive grant funding. Without ARRA funding it is uncertain when this project would have been completed, yet there is a high probability that the necessary renovations would have eventually taken place. Our counterfactual assumes the project would have begun two or five years later (Table 3.1.1, the years marked in green). Thus, when determining the benefit of the Dearborn project, we only consider the benefits accrued during the lag time – the time between the actual ARRA funded Dearborn project and the counterfactual (the years marked in yellow).

Table 5.1.1. Time frame of the Dearborn Subway track renewal project and counterfactuals. Benefits are calculated only for the lag time between when the ARRA project and counterfactual begins.

YEAR	ARRA	LAG2	LAG5
LAG0	2009	2009	2009
LAG1	2010	2010	2010
LAG2	2011	2011	2011
LAG3	2012	2012	2012
LAG4	2013	2013	2013
LAG5	2014	2014	2014
LAG6	2015	2015	2015

year project begins =

years benefits are calculated =

If Dearborn track renovations had not occurred, the CTA projected that slow zones would have increase to 33% by December 2009 (City of Chicago 2010). Thus the benefit of the ARRA funded Dearborn project is the earlier experience of saved time due to the earlier completion of the project. Renovating the Dearborn Subway also had a cost; regardless of when the project occurs (either from ARRA funding or during the counterfactual), the renovations will cause a temporary increase in time delays. However, since the delays from the ARRA funded project occurred in 2009 opposed to two or five years later – the 2009 delays are undiscounted and valued at the full cost. Overall, we aggregated both the time saved and lost from the ARRA funded Dearborn project, and monetized this value based on the average Chicago hourly wage.

5.2. Methodology & Results

As displayed in Table 5.1.1, in order to estimate an increase in time costs from a project lag of two or five years, we considered the timeframe from 2009-2015. First we looked at the costs accrued during the ARRA funded Dearborn Subway project. Using the CTA slow zone

maps (CTA (a) 2011) of the Dearborn Subway, we estimated the increase in passenger time delays during the renovation period, and then monetized these costs. In addition, we assumed after the completion of the project, from 2010-2015, there would be no additional time delays. According to the CTA, at the completion of the project in January 2010, the Dearborn Subway reported no slow zones with trains moving at normal speeds of up to 55 mph. Therefore, for a one-way trip through the Dearborn Subway in 2010, with no stops, we assume it takes:

$$8.6777 \text{ miles} * \frac{4.3388 \text{ miles one-way trip}}{8.6777 \text{ miles round trip}} * \frac{\text{hour}}{55 \text{ miles}} * \frac{60 \text{ minutes}}{\text{hour}} = 4.733 \text{ minutes}$$

Using CTA bus tracker and Google Maps, we estimated the time it takes to get from one end to the other of the Dearborn Metro (from Division to UIC-Halsted) is approximately 14 minutes, with no delays. In order to reconcile the metro time with and without stops, we calculate a rescaling factor:

$$\frac{\text{Dearborn Subway time with stops}}{\text{Dearborn Subway time with no stops}} = \frac{14 \text{ minutes}}{4.733 \text{ minutes}} = 2.958$$

Using this rescaling factor, we can now calculate the travel time through the Dearborn Subway during reconstruction. For example, according to the CTA slow zone map for April 27, 2009, 8,172 feet of track was limited to rail speeds less than 15 mph, and 4,210 feet of track was limited to rail speeds between 15 – 25 mph. Therefore, the one-way travel time through the Dearborn Subway during this time period was:

$$\left(8{,}172 \text{ feet} * \frac{4.3388 \text{ miles one} - \text{way trip}}{8.6777 \text{ miles round trip}} * \frac{\text{mile}}{5280 \text{ feet}} * \frac{\text{hour}}{15 \text{ miles}} * \frac{60 \text{ minutes}}{\text{hour}}\right)$$
$$+ \left(4{,}210 \text{ feet} * \frac{4.3388 \text{ miles one} - \text{way trip}}{8.6777 \text{ miles round trip}} * \frac{\text{miles}}{5280 \text{ feet}} * \frac{\text{hour}}{15 \text{ miles}} * \frac{60 \text{ minutes}}{\text{hour}}\right)$$
$$+ \left(33{,}436 \text{ feet} * \frac{4.3388 \text{ miles one} - \text{way trip}}{8.6777 \text{ miles round trip}} * \frac{\text{miles}}{5280 \text{ feet}} * \frac{\text{hour}}{15 \text{ miles}} * \frac{60 \text{ minutes}}{\text{hour}}\right)$$
$$= 7.506 \text{ minutes with no stops}$$

Rescaled = 7.506 minutes * 2.958 = 22.202 minutes with stops

Table 5.2.1 summarizes the time for a one-way trip through the Dearborn Subway during the renovation and for the years following project completion.

Next, in order to determine the time cost for each passenger, we need to know the number of the riders using the Dearborn Subway per day. According to the Illinois Section of the American Society of Civil Engineers (2011), the Dearborn Subway serves over 165,000 customers per day (the same person using the blue line twice a day would be considered two customers). Yet we do not know how long each passenger uses the Dearborn Subway – while some riders may stay for the entire 4.5 mile track, others may hop off half-way. To account for this difference, we make the assumption that each of the ten stops on the Dearborn track are

evenly distributed from one another, and ridership time follows a normal distribution. Then, by taking the mean value, we assume that the time spent on the Dearborn Subway is the equivalence of 82,500 customers riding the full length of the Dearborn Subway. In comparison, according to the CTA Annual Ridership Report (2010), an average of 579,478 passengers utilized rail on weekdays, with 132,325 (22.8%) passengers boarding on the Blue Line, and 57,175 (9.86%) boarding at the Loop. The Blue line is the second most utilized CTA rail line.

Based on the percentage of customers using the Dearborn Subway on weekends and the 82,500 customers per weekday value, we estimate that there are 34,599 and 24,821 customers utilizing the Dearborn Subway each Saturday and Sunday respectively. Using the number of customers riding the Dearborn Subway each day, and the number of days on the Slow Zone maps, we can now calculate the total additional time for a one-way trip.

For example, for the slow zone dated April 27 – May 18, 2009, there were 16 weekdays, three Saturdays and three Sundays. During this time period, we previously calculated that it takes 22.202 minutes, with stops, to ride the full length of the Dearborn Subway. Thus, the total time for this time period is:

$$\frac{82{,}500 \text{ customers}}{\text{weekday}} * 16 \text{ weekdays} * 22.202 \text{ minutes} * \frac{\text{hour}}{60 \text{ minutes}} = 488{,}444 \text{ hours}$$

$$\frac{34{,}599 \text{ customers}}{\text{weekday}} * 3 \text{ weekdays} * 22.202 \text{ minutes} * \frac{\text{hour}}{60 \text{ minutes}} = 38{,}408 \text{ hours}$$

$$\frac{24{,}821 \text{ customers}}{\text{weekday}} * 3 \text{ weekdays} * 22.202 \text{ minutes} * \frac{\text{hour}}{60 \text{ minutes}} = 27{,}553 \text{ hours}$$

$$\text{Total time} = 488{,}444 \text{ hours} + 38{,}408 \text{ hours} + 27{,}553 \text{ hours} = 554{,}415 \text{ hours}$$

Hours become monetized based on the Chicago hourly wage rate of $23.90/hour (BLS 2010). Since commuting time is valued less than time spent in the workforce, we monetize time costs at 50% of the wage rate, at $11.95/hour. Therefore, in our example for April 27 – May 18, 2009, the total time cost, at a discount rate of 3.2% is:

$$\left(554{,}415 \text{ hours} * \frac{\$11.95}{\text{hour}}\right) * \frac{1}{(1+0.032)^0} = \$6{,}517{,}145$$

The time cost for each period during the renovation, and at the completion of the Dearborn project, is summarized in Table 5.2.2. Overall, the total time cost of the Dearborn Subway renovation project was $446,739,654.

In our counterfactual, we assumed the same project took place, either two or five years later. The delay in the project means that that the slow zones would have increased to 33% starting in December of 2009. We assume these slow zones hold constant at this rate until renovations begin. Using the same method outlined above, we calculate the time cost due to the project delay, during the renovation period and for the years following project completion. Our results for LAG2 and LAG5 are summarized in Annex 3 and 4, Chapter 5 in the Appendix. The difference in time costs between the ARRA funded Dearborn Subway renovation and the

counterfactual equal the total time benefits. Similar to the hybrid bus purchase and O'Hare runway rehabilitation analyses, we include the ARRA grant as a benefit.

Overall, the total benefit of the ARRA funded 2009 Dearborn Subway renovation project is **$135,434,384** with a counterfactual lag time of two years. The total benefit of the project is $247,075,809 with a counterfactual lag time of five years. Our results are summarized in Table 5.2.3 and displayed in Figure 5.2.1. To check the robustness of our results, we test two additional counterfactuals. The first includes an increase in slow zones to 45% starting in year 2013. In the other counterfactual, ridership demand increases to 7% starting in year 2013. A summary of these time costs and total benefits are in Annex 5 and 6, Chapter 5 in the Appendix.

Table 5.2.1. Increase in time delay during the ARRA funded Dearborn Subway project and for the years following project completion. The shaded dates indicate the time period when the project took place.

ARRA FUNDED 2009 DEARBORN SUBWAY RENOVATION PROJECT, WITH 33% SLOW ZONES STARTING DECEMBER 2009						Rescaling factor = 2.9577 (based on a 14 minute, one-way trip with 0% slow zones)	
DATES	15 MPH (FEET)	25 MPH (FEET)	55 MPH (FEET)	TOTAL SLOW ZONE (FEET)	% SLOW ZONE	CALCULATED TIME FOR ONE-WAY TRIP (MINUTES)	RE-SCALED TIME FOR ONE-WAY TRIP (MINUTES)
April 1 - 26, 2009	1,816	4,667	39,335	6,483	14.10	5.812	17.191
April 27 - May 18, 2009	8,172	4,210	33,436	12,382	27.00	7.506	22.202
May 19 - June 1, 2009	24,945	2,704	18,169	27,649	60.30	11.940	35.317
June 2 - 15, 2009	18,217	2,704	24,897	20,921	45.70	10.087	29.835
June 16 - July 6, 2009	13,794	2,704	29,320	16,498	36.00	8.868	26.231
July 7 - August 4, 2009	14,794	2,704	28,320	17,498	38.20	9.144	27.046
August 5 - 19, 2009	8,330	2,704	34,784	11,034	24.10	7.363	21.779
August 20 - 31, 2009	7,255	2,704	35,859	9,959	21.70	7.067	20.903
September 1 -14, 2009	3,147	2,704	39,967	5,851	12.80	5.935	17.556
September 15 - October 1, 2009	7,302	2,704	35,812	10,006	21.80	7.080	20.941
October 2 - 20, 2009	15,342	2,704	27,772	18,046	39.40	9.295	27.492
October 21 - November 10, 2009	11,823	1,342	32,653	13,165	28.70	8.157	24.126
November 11 - 24, 2009	11,519	0	34,299	11,519	25.10	7.907	23.386
November 25 - December 13, 2009	7,197	0	38,621	7,197	15.60	6.716	19.864
December 14 - 30, 2009	2,968	0	42,850	2,968	6.50	5.551	16.418
December 31, 2009 - December 31, 2010	0	0	45,818	0	0.00	4.733	14.000
2011	0	0	45,818	0	0.00	4.733	14.000
2012	0	0	45,818	0	0.00	4.733	14.000
2013	0	0	45,818	0	0.00	4.733	14.000
2014	0	0	45,818	0	0.00	4.733	14.000
2015	0	0	45,818	0	0.00	4.733	14.000

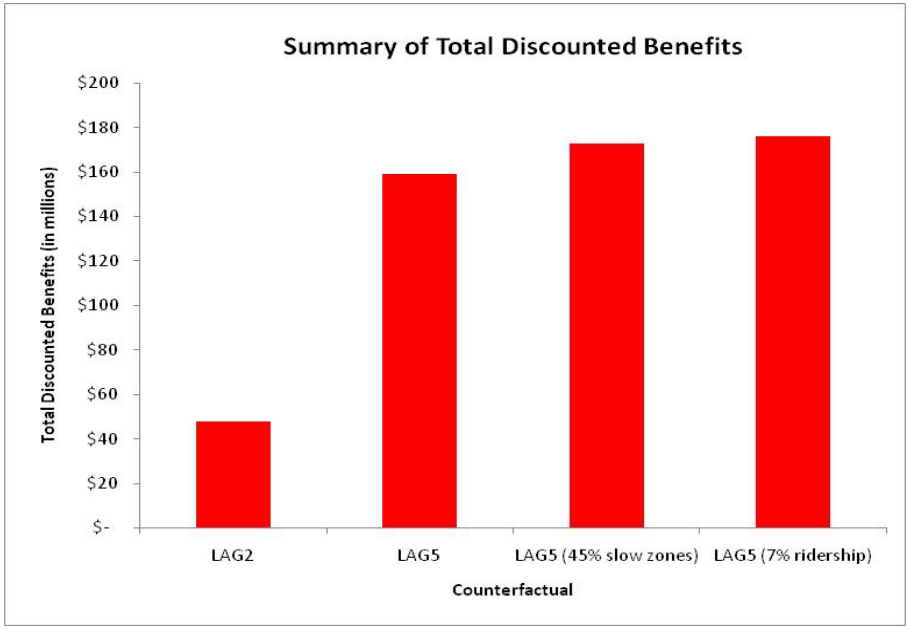
Table 5.2.2. Cost in time (in hours and based on an $11.95/hour) during the ARRA funded Dearborn Subway project and for the years following project completion. Shaded dates indicate the time period when the project took taking place.

ARRA FUNDED 2009 DEARBORN SUBWAY RENOVATION PROJECT, WITH 33% SLOW ZONES STARTING DECEMBER 2009									
					NUMBER OF PASSENGERS/DAY BASED ON CTA RIDERSHIP REPORT				
					WEEKDAY	SATURDAY	SUNDAY		
					82500	34599	24821		
TIME PERIOD	NUMBER OF DAYS IN TIME PERIOD			RE-SCALED TIME FOR ONE-WAY TRIP	PASSENGER TIME FOR ONE-WAY TRIP BASED ON PASSENGERS/DAY & NUMBER OF DAYS IN TIME PERIOD				DISCOUNTED COST OF TIME
	WEEKDAYS	SATURDAYS	SUNDAYS	(MINUTES)	WEEKDAY (HOURS)	SATURDAY (HOURS)	SUNDAY (HOURS)	TOTAL TIME (HOURS)	
April 1 - 26, 2009	13	3	3	17.191	307,288	29,739	21,334	358,362	$ 4,212,547
April 27 - May 18, 2009	16	3	3	22.202	488,452	38,409	27,554	554,415	$ 6,517,145
May 19 - June 1, 2009	10	2	2	35.317	485,610	40,731	29,220	555,561	$ 6,530,620
June 2 - 15, 2009	10	2	2	29.835	410,231	34,409	24,684	469,324	$ 5,516,905
June 16 - July 6, 2009	15	3	3	26.231	541,016	45,378	32,553	618,948	$ 7,275,730
July 7 - August 4, 2009	22	4	4	27.046	818,138	62,384	44,753	925,275	$ 10,876,608
August 5 - 19, 2009	11	2	2	21.779	329,406	25,118	18,019	372,542	$ 4,379,235
August 20 - 31, 2009	8	2	2	20.903	229,933	24,107	17,294	271,334	$ 3,189,534
September 1 -14, 2009	10	2	2	17.556	241,391	20,247	14,525	276,163	$ 3,246,292
September 15 - October 1, 2009	13	2	2	20.941	374,325	24,152	17,326	415,803	$ 4,887,759
October 2 - 20, 2009	13	3	3	27.492	491,427	47,560	34,119	573,106	$ 6,736,862
October 21 - November 10, 2009	15	3	3	24.126	497,592	41,736	29,941	569,269	$ 6,691,752
November 11 - 24, 2009	10	2	2	23.386	321,556	26,971	19,348	367,875	$ 4,324,373
November 25 - December 13, 2009	13	3	3	19.864	355,073	34,364	24,652	414,090	$ 4,867,623
December 14 - 30, 2009	13	2	2	16.418	293,479	18,935	13,584	325,998	$ 3,832,102
December 31, 2009 - December 31, 2010	262	52	52	14.000	5,043,500	419,801	301,155	5,764,457	$ 65,660,065
2011	260	53	52	14.000	5,005,000	427,874	301,155	5,734,030	$ 63,288,263
2012	261	52	53	14.000	5,024,250	419,801	306,947	5,750,998	$ 61,507,314
2013	261	52	53	14.000	5,024,250	419,801	306,947	5,750,998	$ 59,600,110
2014	261	52	52	14.000	5,024,250	419,801	301,155	5,745,207	$ 57,693,887
2015	261	52	52	14.000	5,024,250	419,801	301,155	5,745,207	$ 55,904,929
								TOTAL TIME COST =	$ 446,739,654

Table 5.2.3: Summary of total discounted benefits of ARRA funded 2009 Dearborn Subway renovation project, under stated counterfactuals.

BASELINE ASSUMPTIONS	COST IN HOURS	TIME COST IN WAGES	COST DIFFERENCE IN YEARS FROM ARRA 2009	COST DIFFERENCE IN WAGES FROM ARRA 2009 = TOTAL TIME BENEFIT	TOTAL DISCOUNTED BENEFITS (TIME COST + ARRA GRANT
ARRA 2009 @ 33% slow zones	41,558,959	$ 446,739,654	--	--	--
LAG2 2011 @ 33% slow zones	45,895,041	$ 494,374,038	495	$ 47,634,384	$ 135,434,384
LAG5 2014 @ 33% slow zones	56,594,498	$ 606,015,464	1,716	$ 159,275,809	$ 247,075,809
LAG5 2014 @ 2013 45% slow zones	57,894,035	$ 619,483,132	1,865	$ 172,743,478	$ 260,543,478
LAG5 2014 @ 2013 7% ridership growth	58,249,967	$ 622,724,360	1,905	$ 175,984,706	$ 263,784,706

Figure 5.2.1. Summary of total discounted benefits of ARRA funded 2009 Dearborn Subway renovation project (not including the ARRA grant) under stated counterfactuals.



6. Conclusions

The net present values of the three cost-benefit analyses are summarized below in Table 6.1. These cost-benefit analyses reflect approximately $151.6 million (nearly 25%) of ARRA transportation and infrastructure investments, and had a total net present value of $313 million. Two points should be reiterated. First, unlike some of the other ARRA funded cost-benefit analyses conducted (such as in the energy or housing sector), the ARRA grant is included as a long-term capital benefit. Second, without the ARRA grant included as a benefit, we feel that the net present value of a majority of transportation and infrastructure benefits would have been negative. This stems from the fact that infrastructure and transportations repairs are perpetually ongoing; without the ARRA grant, in a matter of time, they would have undoubtedly still occurred.

Table 6.1. Net present value of three transportation and infrastructure cost-benefit analyses.

CBA SUMMARIES			
Project	**ARRA Funding**	**Impact Measure**	**Net Present Value**
Dearborn Subway Rehabilitation	$87.8M	$47.6M	$135.4M
O'Hara Runway Rehabilitation	$12.3M	$10.5M	$22.8M
Purchase of Hybrid Buses	$51.5M	$103.4M	$154.9M

In addition, equipped with information regarding the different transportation and infrastructure programs funded, we considered the potential economic impacts for each program area. This report includes a literature review of our research into those impacts and measurement strategies. The literature review is intended to motivate future analysis within the individual program areas.

Chapter 6. Energy and the Environment

1. Overview

The American Reinvestment and Recovery Act (ARRA) signed into law February 2009 provided billions of dollars for projects aimed at moving the nation toward a greener future. Through the Chicago Recovery Partnership, Chicago was able to secure over $170 million for local energy and environmental projects. The funds are being used to help advance Chicago's Climate Action Plan, which is aimed at moving Chicago toward cleaner and more energy efficient future[52].

Chicago's environmental and energy ARRA projects cover a variety of areas, ranging from the retrofitting of buildings, replacing streetlights with new efficiently LED lighting, and supporting the adoption of alternative fuel vehicle use. A summary of Chicago's Environmental and Energy projects funded by ARRA stimulus dollars is provided in Appendix A. This paper provides two-detailed Cost Benefit Analyses (CBA) for two projects; the Low Income Weatherization Program and the Chicago Area Alternative Fuel Deployment Project.

1.1. Low Income Weatherization Program

A national federal program run by U.S. Dept. of Energy (DOE) first established in year 1976, the Low Income Weatherization Program received an allocation of an additional $5 billion in ARRA funding for weatherization activities nationwide. The funds were distributed to states, which then distributed dollars to local agencies for program implementation. The Community and Economic Development Association of Cook County received $90 million from ARRA targeted for weatherization of low income homes in the Chicago land area and was tasked with overseeing the distribution of funds marked for weatherization of low-income homes in Cook County.

The program's goal is to reduce energy use in low-income homes. This can include making improvements such as window caulking and insulation installation and acquiring new energy efficient equipment such as a new refrigerator, lighting, radiator, etc.

Given the program's long history, extensive cost benefit analyses of these weatherization programs have already been completed on a national level by the Oak Ridge Laboratory on behalf of the Department of Energy. These reports were reviewed and critiqued as part of our preliminary analysis. In an effort to follow consistency of literature, much of the methodology used by the Department of Energy was applied to the CBA of Chicago's weatherization efforts.

[52] Chicago Recovery Partnership – The City of Chicago's ARRA Collaboration with the Chicago Philanthropic Community. Status Report, October 2009. Link

1.2. Chicago Area Alternative Fuels Deployment Project

Funded under the U.S. Department of Energy's Clean Cities program, the Chicago Area Alternative Fuels Deployment Project (CAFD) is part of national effort to transition the nation's vehicle fleet to alternative fuel and reduce America's petroleum consumption. The DOE program offers funding to support the purchase of alternative fuel vehicles and also helps finance the construction of a new network of alternative refueling stations across the country.

The Clean Cities program is a government-industry partnership that provides cost sharing grants to local government or non-profit organizations to support alternative fuel vehicle use. The program received an additional $300 million as part of the ARRA program. Twenty-three recipients were selected across the country to receive a portion of the stimulus funds. Chicago was selected to receive a $15 million allocation aimed at increasing the use of alternative vehicles within the Chicago land area. Chicago's Department of Environment (CDOE) is responsible for overseeing the funds distribution and overall project management activities. The Gas Technology Institute and Chicago Area Clean Cities Coalition also provided support activities.

The CAFD project is still in the early phases of execution. Only 57 of alternative fuel vehicles have been deployed, while construction was completed on 38 of the 113 planned fueling stations[53]. However, the planning stage of the project has been fully completed, allowing data to be collected on the total number of planned alternative fuel vehicles and refueling stations.

2. Cost Benefit Analysis - Low Income Weatherization

2.1. Background

Created in 1976, following a spike in energy prices following the 1973 oil embargo, the Department of Energy's Weatherization Assistance Program was designed to cut the country's dependence on foreign oil and lower the utility bills of low income households. The program has grown both in size and sophistication. Originally concentrated on low-cost weatherization efforts such as covering windows with plastic sheets and caulking of a house's external façade, the program has now grown to include a wider array of energy saving initiatives. Households with incomes below 200% of the federal poverty level are eligible for the program and must register with their local agency responsible for running the weatherization program. Preliminary energy audits are conducted in each eligible household to help determine the most cost effective activities that are to be performed on each house. Homes are then prioritized based on the household income and the homes' potential energy savings.

[53] As reported by Chicago's Department of Transportation, May 2011.

2.1.1. Methodology

Our analysis includes homes that were weatherized solely within Cook County and were strictly funded through additional ARRA dollars. As mentioned above, the methodology used to measure the benefits and cost of weatherization efforts comes from prior CBA analysis done by DOE on a national level. Two main papers, both published by the Oak Ridge National Laboratory on behalf of the DOE, provide the basis for the CBA methods used in our analysis (Eisenburg 2010, Schweitzer and Tonn 2002). When possible, measurements were adjusted to Chicago specific criteria in an effort to provide a more accurate picture of benefits and cost over the national averages used in the DOE papers.

2.1.2. Direct Energy Savings

The benefits of home weatherization can be separated into two major groups; direct and non- direct energy savings. Direct energy savings are those received solely by the homeowner or resident. These include lower energy use for heating or cooling and lower electricity in the home as a result of the new insulation, window caulking, radiator replacement, or other energy efficiency improvements carried out as part of the program. Heating and cooling savings were measured in MBTus (British Thermal Unit), the standard unit of measure of energy needed to produce heating or cooling. Electricity savings were measured in kilowatts (Kwh). These savings were then converted to dollars based on current energy prices for Chicago[54].

The program's heating and cooling energy savings were estimated nationwide to be 30 MBTus annually per household based on a 1300 square foot home. However, Chicago's harsh climate environment allows for the potential of substantially higher heating and cooling savings from home weatherization. The DOE estimate accounts for these variation in potential savings by providing specific estimates for each of the nation's four geographical regions – West, South, Midwest, and Northeast. We applied the more accurate Midwest estimate for our analysis. This localized estimate also accounts for the fact that natural gas is the predominate source of heating homes in Chicago. Using these localized estimates, we get a projected energy savings of 48 MBTus, with a monetized value of $757 in savings per year. A breakdown of these savings can be seen in Table 1.

Given electricity usage is not greatly influenced by climate variations, we are comfortable using the national average used by DOE for estimating a house's base load electricity savings. The average estimate was an annually savings of 870kwh per household. The average price of $.14 per kwh for Chicago residential consumers in December 2010 was used to convert these savings to dollars. The result was $125 annual savings in electricity charges per year.

[54] Bureau of Labor Statistics, Midwest Information Office. Average Energy Prices in Chicago Area – December 2010. Link

The range of potential non-energy benefits is much broader. The DOE study names a total of seven main non-energy categories, each with a sub section of benefits. Unfortunately, we believe many of these benefits are vulnerable to criticism and if used, open the door to criticism of our final numbers. For example, the DEO reports added monetary value for increased national security as a result of lower dependence on foreign oil and also included estimates received by fellow utility customers resulting from lower overall market demand coming from the newly weatherized homes. These estimates are incredibly difficult to monetize and often result in broad range of estimates. Furthermore, when combined with the primary benefits of home weatherization, these factors only account for a small percentage of the total benefits received from a homes weatherization. For these reasons, we decided to only include benefits that were deemed to be the most uncontroversial in hopes of providing an estimate that is less susceptible to criticism.

Table 1 – Home Benefits from Weatherization

Low Income Weatherization Benefit Breakdown Annual Basis, 1300 sq ft home			
Direct Energy Savings		**In-Direct Energy Benefits**	
MBTUs Saved Heating/Cooling	48	Carbon Reduction (metric tons)	2.65
$ per MBTU	$15.77	$ per Metric Ton	$26.00
Heating Cooling Energy Savings	**$756.96**	**Environmental Benefits**	**$68.90**
Kwh Saved	870	Improved Health of Residents	$4.00
$ per Kwh	$0.144	Reduction in likelihood of Fire	$6.00
Electricity Energy Savings	**$125.28**	**Health and Safety Benefits**	**$10.00**
Total Direct Energy Benefit	***$882.24***	***Total Direct Energy Benefit***	***$78.90***
Total Benefits per House	***$961.14***		

2.1.3. Non-Direct Energy Savings

The first and arguably most publicized non-direct energy benefits, or those shared by society, is the environmental benefit of lower pollution from a weatherized home's lower energy use. Lower pollution benefits require a number of factors be estimated in order to come to final monetized numbers. These include the number of pollutants emitted per MBTu, the number of MBTus saved per household weatherization, and the value in dollars associated with reducing each pollutant. The most difficult of these is the task of putting a dollar value on each pollutant. The first approach is to use a market valuation method that prices pollutants based on the value of emission permits being traded in an emissions market (or the expected value for such permits if the market does not yet exist). The second approach makes an attempt to include a wider area of benefits such as direct health improvements, decreased destruction of eco-systems, or the decreasing rates of deterioration of exterior buildings and/or other outdoor assets. While the

market approach may result in a much lower overall price for pollutants, it also provides a much smaller range of estimates when compared to the comprehensive benefit approach. For this reason, the environmental estimates used in this analysis are driven primarily off a market approach of measuring the value of reduced pollution (see Appendix B). We calculated an annual benefit for a 1300 sq foot homes reduced carbon emissions at $69 per year.

In addition to the environmental benefits, we account for the expected increase in comfort and safety to residents of homes that are weatherized. Replacing old heating and cooling equipment reduces the likelihood of these old products malfunctioning that can often lead to fire or other damage. Improved temperature control of households can also lead to a decrease in illnesses – especially with the elderly. Lower illness rates decrease health expenses and can lead to fewer lost days of work. We used the DOE estimate of $10 of annual benefits in a 1300 sq ft home to account for these positive factors.

2.1.4. Lifespan and Discounting

While the costs of weatherization programs are realized in a one-time upfront payment, the benefits continued to be received over the long term. Following DOE guidelines, the weatherization benefits were expected to have a lifespan of 20 years. These benefits must be discounted given much of the savings will not be realized until future years. Following the Office of Management and Budget suggestions, a discount rate of 3.2% was used to measure the net present value of all weatherization benefits.

We assume the initial cost estimates we calculated only account for direct weatherization cost such as labor and materials. We believe this omits the significant cost associated with administrating the program. Therefore, we estimate an additional 20% cost for oversight and administration activities. We admit this has potential to ignore any benefit these administrative activates create such as job creation or further economic activity. However, we believe any of these benefits are short lived and overall minimal when compared to the larger long-term benefits already accounted for in our findings.

2.2. Key Findings

As of the end of 2010, CEDO had completed the weatherization of an additional 4358 homes in Cook County as a direct result of the additional ARRA funding, with another 3361 homes scheduled; bringing the total to 7719 homes[55]. The total monetized benefits of weatherization activities were estimated at $13,817 per household in 2009 dollars. Over 90% of these savings come from direct energy savings received by the resident of the home. Using CEDA's reported numbers of 4358 homes completed with $18 million in ARRA funding so far, we calculate an average cost of $4161 per weatherized home. A 20% overhead cost was added for administrating the program, giving a total average cost of $4993 per house –slightly below the $5703 national average reported by DOE. Aggregating these numbers to the program level,

[55] Assumes these additional 3361 are completely funded by ARRA funds.

we expect the $38.5 million of ARRA funding currently scheduled for weatherization of low-income homes to bring just over $106 million in total benefits to Chicago residents. A break down of these calculations can be seen in Table 1 and 2. Total net benefits come in at $68.1 million and provide a benefit cost ratio of 2.75. It was also projected that a total of 227 jobs were created or retained as a result of ARRA weatherization program in Cook County[56].

Table 2 – Summary of Weatherization Benefit Calculations

Low Income Weatherization Benefit Summary	
Annual Savings per 1300 sq ft House	
Heating Cooling Savings	$757.00
Electricity Savings	$125.00
Emission/Pollution Reduction	$69.00
Health/Safety Benefit	$10.00
Total Annual Savings	**$961.00**
Present Value of Savings (2009 Dollars) *(20 yr lifespan, 3.2% discount rate)*	**$13,817.00**
Number of Homes Weatherized	
# of Homes Served by Program through 12/10	4358
# of Homes planned as of 12/10	3361
Total # of homes completed/planned through 12/10	7719
Program Cost	
ARRA Funds spent through 12/10	$18,133,962
Estimated Average Cost per Home	$4,161.07
20% Administration and Overhead Estimate	$832.21
Estimated Total Cost per Weatherized Home	$4,993.29
Total Cost of 7719 Weatherized Homes	$38,543,199.45
Total NPV of Benefits of 7719 Homes	$106,653,423.00
Total Net Benefit	$68,110,223.55

2.3. Study Limitations

As with any cost benefit analysis, it is important to understand the limitations of these results. Given the incomplete data and limited resources, several assumptions were made in order to come to a final monetized value of the Chicago program. Some of these limitations are highlighted below.

[56] The financial benefits of the jobs were not included in our benefit analysis. See study limitation section for further explanation.

2.3.1. Jobs

The Illinois Department of Commerce and Economic Development has reported that a total of 528 jobs have been created or retained as a result of the additional ARRA funding that was allocated to weatherization activities in the State of Illinois. Given that Cook County accounted for 43% of the total homes weatherized in Illinois under the program, an estimate of 227 jobs created/retained was reported for the final number in Cook County. We believe this is an important statistic and thus cited it in the key findings section, but believe that more specific numbers from CEDA should be provided on both number of jobs created/retained and on average salaries before a formal financial estimated be included in the benefit factor of home weatherization.

2.3.2. Energy Price Uncertainty

This study also assumes an unrealistic constant trend in future energy prices. A quick look at historical residential energy prices from 1949-2010 shows a substantial variation in prices. Energy savings will vary with fluctuations in the price faced by consumers. Clearly a spike in energy prices over the next 20 years could have the potential to substantially push up the direct energy savings realized by residents, who thanks to the weatherization program, will being purchasing less higher priced energy than they would have in the absence of the program. At the same time, lower energy prices as a result of improved technology by energy suppliers could result in the estimate of consumer energy savings being over stated.

2.3.3. Exemption of Other Social Benefits Allow for Conservative Benefit Estimates

It is important to also point out that the total monetized benefits for this study is lower than it could be due that several potential benefits have been left out of the calculation. These items were mainly left out of our analysis due to unavailability of data or to the difficulty of putting a monetized value on such benefits. These potential benefits include items such as the increase in property values, savings for non-weatherization resident utility customers, or the possible multiplier effect of increased economic activity resulting from the program. In addition the exemption of these possible benefits, the DOE estimates used in this analysis have a built in 20 percent reduction in heating and cooling savings predicted by their modeling. This reduction was built in to specifically target the risk of any exaggeration in the program's performance.

3. Cost Benefit Analysis – Chicago Alternative Fuel Deployment

3.1. Program Background

Different from other ARRA grant programs, the Chicago Alternative Fuel Deployment (CAFD) project is a cost-sharing project that required private firms to put forth financial commitments in order to be eligible to receive a portion of the $15 million. The program was able to generate an additional $24.6 million in alternative fuel investment from the private industry, bringing the total project budget to just under $40 million.

The project plans to purchase or retrofit 546 alternative fuel and/or hybrid vehicles in Chicago. In addition, CDOE plans to support the construction of 113 alternative fueling stations to support the growth of alternative fuel use in the future[57].

3.2. Methodology – Vehicle Transformation

To calculate the estimated reduction in CO2 pollution, we used the GREET Fleet Footprint Model developed by the Argonne National Laboratory. Originally developed at the request of the Department of Energy in 1998, Argonne developed the GREET tool to assist state and local officials with calculating the estimated reduction in pollutants by shifting a fleet of vehicles away from petroleum and towards an alternative fuel power. The tool provides two specific calculations for our analysis. The first is an estimated use of petroleum for a specific vehicle fleet. Secondly, the GREET tool provides a fleet's estimated CO2 emissions.

The GREET tool requires four inputs in order to calculate these estimates. First, the number of vehicles in each fleet is entered. Second, the type of fuel used for each vehicle must be specified. Third, the user must enter the estimated number of annual miles traveled by each vehicle. Finally, miles per gallon (MPG) must be entered for each vehicle type.

Data provided by the Chicago Department of Environment listed each fleet participant, the proposed new vehicle replacement, and fuel type for their new alternative fuel fleet. Status quo fleet vehicle type/model were estimated based on common petroleum vehicle used by similar fleet operators. When the new alternative vehicle fleet involved converting an existing vehicles engine, the equivalent petroleum fueled vehicle was assumed. Annual vehicle miles were estimated again based on national averages, with taxi's having significantly higher annual

[57] After additional infusion of funding was received by the City and applied to the CAFD project after the initial project kick of in 2010. This new funding was combined with the original ARRA budget, allowing for an additional 280 electric charging stations to be added to original project scope. However, data was not available on what portion of these new stations would be funded by ARRA funds vs. the new funding sources and thus are not included in the total station count used for our analysis.

mileage use based on their unique use.[58] Finally, the U.S. Department of Energy *www.fueleconomy.gov* website was used to gather MPG estimates. The majority of vehicles were listed on the DOE site. However, given the uniqueness and relatively early phase of adoption for several alternative fuel vehicles, data was not available on some of the compressed natural gas (CNG) conversion vehicles. In these instances, the equivalent petroleum engine mpg was used.

Given this framework, we broke each participant's fleet into two different categories: pre-CAFD fleet and post- CAFD fleet. The Green Taxi component of the CAFD project provides a solid example of how the methodology described above was applied. The Green Taxi component provided funding to replace 250 operating taxis with new hybrid Ford Escape vehicles. Since these were new vehicles and not alternative conversions, a status quo vehicle needed to be selected to compare against the new hybrids. Based on similar operators' fleets, the Ford Crown Victoria is the petroleum vehicle of most use within the industry and thus assumingly would be used in the absence of the new hybrid vehicles. Thus, the Ford Crown Victoria was used as the comparable Pre-CAFD fleet vehicles. Annual mileage estimates were recorded, along with MPG statistics for both the Ford Crown Victoria and Ford Hybrid Escape. The Greet model was first run with the Pre-CAFD Ford Crown Vic fleet. These output calculations were than compared to a second run of the GREET tool using the Post-CAFD Hybrid Escape fleet metrics. The changes in both petroleum use and CO2 emissions between the two fleets were recorded and used in calculating the financial benefit of the fleet transition. This process was then repeated for all 22 fleet transformations.

3.2.1. Benefits Lifespan and Discounting:

It is expected that all of the CAFD project funds will be expended by December 2013. However, as with other green investments, the benefits of using a greener vehicle advances continue to be received as long as the cleaner vehicle is used. A recent R.L. Polk survey shows average age of passenger vehicles in the USA to be 10.2-years old. The same survey claims that U.S. Class 8 tractor (semi-truck) average age of 10.3 years –similar to average passenger vehicle age.[59] As a result, we decided to assume each vehicle would be in operation for 10 years. In an effort to be consistent with other CBA analysis carried out in this paper, a 3.2% discount rate was used to calculate the Net Present Value of the lifetime benefits of the new alternative vehicle fleet.

[58] Taxi mileage was estimated at 60,000 per year based on the Taxicab, Limousine & Paratransit Association. All other vehicles average 15, 000 miles per year.

[59] "Polk Finds More Vehicles Scrapped than Added to Fleet", RL Polk Co. March 30, 2010. Link and "Commercial Vehicle Market Intelligence Report" RL Polk Co. December 2009. Link

3.2.2. Fuel Prices

An assortment of fuel prices were used to calculate any savings based on the diversity of prices each fleet owner may face in the absence of owning a new alternative fuel fleet. The City of Chicago enters into long term fuel contracts to help hedge against price volatility. As of the release of this paper, the city had fuel contracts for $3.37 per gallon of unleaded and $3.49 per gallon of diesel fuel. It is also likely that other fleet owners in the CAFD program have long-term fuel contracts; however, we were unable to retrieve additional contract fuel price data specific to fleet owners for our analysis. Therefore, for all other fleet owners, the historical 2-year average retail price of diesel and unleaded fuel was used in our fuel cost calculations.

Pricing for compressed gas is usually priced in gasoline gallon equivalent, or GGE. Using this metric allows for easy side-to-side comparison to conventional petroleum prices. As with petroleum fuel purchases, the City of Chicago also has a long-term contract for CNG fuel. As a result, the City of Chicago faces a price of $2.26 per GGE. For other fleet owners, the historical 2-year average price of a GGE reported by the U.S. Department of Energy's Clean Cities Alternative Fuel Price Report was used.[60]

3.3. Methodology – Refueling Station Infrastructure Network

Unlike the vehicle portion of the project, calculating a financial benefit for the refueling stations is much more difficult to determine. Given this is a cost-share project, one simple option is to aggregate the total value of all new stations and compare this to the financial contributions of the grant. However, this method ignores any benefit the new stations may have on encouraging higher use of alternative fuel vehicles. As with other network dependent technologies, the adoption of alternative vehicles depends as much upon an accessible/robust network of refueling stations as it does on the availability of the vehicles themselves. This standard chicken-or-egg first scenario places a value on the expansion of a support network even prior to the adoption of the underlying technology.

Governments and manufacturers of alternative fuel vehicles have long struggled with finding the minimum network coverage of refueling stations that is needed to assure potential alternative fuel customers that refueling will not hinder their ability to travel in their new vehicle. There are several factors that go into understanding this minimum threshold. First and foremost is the alternative vehicles range. Clearly, a much more robust network than what is provided by the CAFD program alone is needed for CNG and EV vehicle use given these vehicles range is limited to between 200-250 miles (Brinkerhoff 2009). A lower threshold is needed for a PHEV, whose owner can rely on the vehicles petroleum engine to kick in after the vehicle's battery is depleted and thus can rely on the extensive gasoline-refueling infrastructure already in place. Regardless, the threshold is unknown. These uncertainties compound the difficulty in

[60] U.S. Department of Energy. Average Retail Fuel Prices in the U.S. Table Trend of alternative and traditional motor fuel prices from 2000-2010 Link

determining if the new CAFD funded stations provide the minimum amount of refueling coverage for widespread adoption of alternative vehicles in Chicago.

Nonetheless, any addition to the alternative fuel-refueling network most likely holds a value greater than $0. Current and potential alternative vehicle owner would prefer the post CAFD network to the smaller pre-CAFD network. In an effort to calculate an estimated financial benefit, we looked at a range of levels the new refueling stations may have on enticing alternative fuel adoption. We calculated estimates that the new stations added to the alternative fueling network would increase alternative fuel vehicle use in Chicago by 10%, 25% and 35% per year over the next 10 years. We then calculated the fuel savings and CO2 reduction benefits of an increased Chicago alternative vehicle fleet.

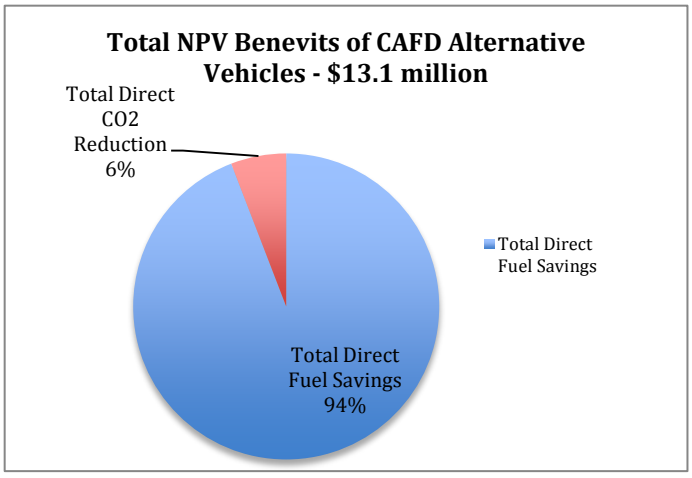
However, this type of sensitivity analysis still proves challenging. First, even if it is assumed that expanding the alternative fuel refueling network will help spur alternative fuel vehicle use, what type of growth numbers should be used is unknown. Thus our 10%, 25%, and 35% estimates are purely arbitrary. We also assumed the status quo alternative vehicle fleet to be that of only vehicles that were part of the CAFD program, given this is the only vehicle data we have available. This does not include any alternative vehicles outside of the CAFD program that were already being used in Chicago. Finally, the calculations do not take into account other critical factors that go into a successful refueling network such as utility modernization, regulatory approvals, or the need to educate consumers on the new refueling procedures.

Therefore, while the above calculations maybe interesting to our reader, we believe there are too many variables to this methodology to include them in our aggregate calculations. However, we believe government leaders and policymakers should understand that there is a potential value in building network of alternative fueling stations and therefore have included our sensitivity analysis in Appendix C.

3.4. Key Findings

3.4.1. Vehicle Transformation

Given the CAFD project is still in the early phases of deployment, our analysis assumes full deployment of all planned vehicles of the original CAFD budget. The annual direct fuel savings were estimated to be $1,533,688 per year for all 546 vehicles. These savings total $12.31 million in 2009 dollars, assuming a ten-year vehicle lifespan and constant fuel prices. 3662 tons of CO2 emissions are saved each year, equaling $90,822 per year. Again, over a ten-year life span the emission savings net present value is equal to $766,884.



Total benefits of the program come to $13.1 million. Comparing this to the $4 million portion of the federal grant that was directed toward subsidizing alternative fuel vehicle purchases, provides a net benefit of $9.1 million and a benefit to cost ratio of 3.28.

3.4.2. Refueling Station Infrastructure Network

As mentioned above, we do not feel comfortable calculating a financial value of the social benefits of extending Chicago's alternative fuel refueling network due to the uncertainty in the positive externalities that result from increasing the alternative fuel refueling network. This should not lead the reader to conclude that the additional stations provide no benefits. In fact we, believe there some range of social benefit from the increased stations and therefore have compiled an Appendix C with a possible range of benefits of the additional refueling stations that can be reviewed for informational purposes. In addition, it is estimated that a total of 77 FTE jobs were created/retained for a full year as a result of the CAFD project, mostly from the construction of the refueling stations.

3.5. Study Limitations

As with any cost benefit analysis, it is important to understand the limitations of these results. Given the incomplete data and limited resources, several assumptions were made in order to come to a final monetized value of the Chicago program. Some of these limitations are highlighted below.

3.5.1. Jobs

The Chicago Department of Environment has reported job estimates for each component of the CAFD project. These include construction, vehicle conversion, and station on-going maintenance activities. These estimates total 77 jobs over the lifespan of the project. We believe this is an important statistic and thus cited it in the key findings section, but believe that specific

salary data should be tracked given the range of positions before a formal financial estimate be included in the benefit factor of CAFD program.

3.5.2. Energy Price Uncertainty

This study also assumes an unrealistic constant trend in fuel prices. A quick look at historical fuel prices shows a high level of volatility. Any dramatic shift upward in petroleum prices would result in a higher direct fuel savings benefit to fleet owners. While at the same time, lower prices of unleaded/diesel fuel would lower the benefits of alternative fuel vehicles. The U.S. Energy Information Administration does forecast slightly higher gasoline prices in 2012 and sees higher crude oil prices over the next 25 years, but cautions that such estimates are difficult to determine[61].

3.5.3. Elasticity to Participate

Federal assistance ranged from 33%-100% of the additional cost fleet owners faced in their decision to purchase/convert their fleet to an alternative fuel vehicle vs. traditional petroleum only fleet. We have made the assumption that none of the mentioned activities of the CAFD project would have taken place in the absence of the ARRA grant subsidy. This may or not have been the case. It is possible that several of the partners involved in the CAFD project would have moved forward with transitioning to an alternative fuel vehicle fleet without any government assistance. Oftentimes, the fuel savings resulting from transitioning to an alternative fuel fleet can justify the transition cost without any subsidy. As the number of alternative vehicle purchases that would have occurred absent the ARRA subsidy increases, the benefit of the program on a whole diminishes. While we don't know the share of alternative fuel vehicles in the program that fall within this category, we assume it is greater than 0 and thus believe there is a risk that benefits may be slightly overstated at some level.

3.5.4. Mileage Estimates

Variances in driving conditions and annual distances have the potential to significantly alter the benefits of the CAFD program. The 15,000-mile average used for all non-taxi use vehicles in this study does not take into account the variance in use across the different vehicles followed in this study. The Chicago Department of Environment is tracking actual mileage of each CAFD funded vehicle. Unfortunately, the project is in the early phases of vehicle deployment and therefore the actual mileage data is not yet available. Once all vehicles have been deployed, more accurate mileage data will be available and a more accurate benefit calculation can be compiled.

[61] See U.S. Energy Information Administration Short Term Energy Outlook Link and the Annual Energy Outlook Report, April 2011. Link

4. Recommendations

4.1. Low Income Weatherization

The ARRA legislation allowed for slight modifications in the guidelines administrating agencies must follow to receive DOE funding. The most important of the changes was the raising of the average cost ceiling for investment per unit to $6500, up from the previous ceiling set at $3000. This can have an important impact on the program's national funding and the formula for disbursing money across states. With a higher cost ceiling per household, the threshold for cost effective households is lowered, resulting in more funding being directed to states with more temperate climates.

Yet, the literature has consistently shown that weatherization projects in locations with harsh climates can provide the potential for significantly higher savings than more temperate weather. Logically, harsher winters require more energy to heat, multiplying the savings that can come from a more energy efficient home. This assumption is backed up by the DOE study, showing that savings coming from homes in the Midwest consistently provide estimates of annual heating and cooling savings 60% higher than the nation's average. This should be a staple argument in any additional request for funding, as dollars allocated to Chicago weatherization programs are likely to provide higher energy savings than those that are directed to states with more timid climates.

It is also important that any additional funding support for weatherization programs in Chicago be accompanied by increased data tracking efforts. Currently it is difficult to find specific details of the homes that are targeted in Chicago for weatherization activates. What is the average square footage of houses receiving weatherization services in Cook County? How many homes are multi-dwelling vs. single-family homes? What is the proportion that is rented vs. owned? For example, low –income residents are more likely to rent rather than own. Yet, the weatherization program today is structured with incentives that can result in market failure when it comes to energy retrofits for rental properties. Currently the landlord must agree to fund part of the cost of the weatherization activities in order to be eligible for weatherization funds, even though the tenant may receive the majority of the programs benefits. The result can be missed weatherization opportunities with strong benefit/cost ratios. More complete data would provide program officials with data needed to help address these perverse incentives as well as support further analysis in ways that could help the Chicago weatherization programs out perform other state programs.

4.2. Chicago Alternative Fuel Deployment

As with the Low Income Weatherization, the availability of careful data gathering during both project deployment and throughout the project deployment can help provide policy makers with a better understanding of how to guide future funding. Fortunately, the CAFD project has already established a process for both tracking vehicle mileage and fuel consumption per quarter.

In addition, the alternative fuel stations will track the amount of fuel dispensed. The data tracking is part of the Clean City Initiative reporting sent to the DOE for national comparison, but can also be used by local authorities to understand which alternative fuel vehicle and stations are producing the highest level of use and benefit depending on fuel type, location, vehicle type, etc.

As mentioned above, one of the greatest challenges of our analysis on the CAFD program revolves around calculating the benefits of the increased refueling station network. In the absence of a definitive financial benefit value for the additional station, we do have two recommendations based on other research related to the importance of alternative fuel refueling stating infrastructure. First, it is important that home charging stations be included in the overall strategy of any alternative vehicle adoption plan. While public charging stations are an important factor to driving the growth of alternative fuel vehicle adoption, it is widely expected that most charging of electric vehicles will be done at the home. Home station charging availability cannot be overlooked in the City's effort to make owning an electric car in Chicago viable. Support does not have to be limited to direct subsidy's toward the purchase of home charging stations but should also include educational efforts aimed at informing the public on how to transition to electric car ownership. Such educational programs can help overcome the confusion and apprehension hindering electric car adoption – specifically "range anxiety", often cited as a major factor prohibiting greater uptake of electric cars by consumers who are fearful that cars will run out of power mid journey.

The major benefit of adding new alternative fuel refueling stations is the increased alternative vehicle adoption resulting from increased station coverage. One of the clearest ways this benefit can be demonstrated is by an increased rollout of alternative vehicles to the Chicago market by major automakers. Makers of electric, hybrid, and CNG vehicles strategically choose with markets to rollout these vehicles in based on their analysis of a regions ability to support the new technology. Thus far, Ford Motor Co. is the only major automaker to have included Chicago as an initial rollout city for electric car sales, with the planned introduction of the electric Ford Focus at the end of 2011[62]. While automakers have repeatedly said that a robust charging structure is important factor in determining rollout cities, they also include the importance of both support from the major public utilities and local politicians. Government officials should make an effort to work in conjunction with automakers in their efforts to build a friendly alternative fuel city – as the automakers that can provide extensive information on the necessary commitments needed to make alternative vehicle use viable for Chicago residents.

5. Conclusion

It is our hope that this report provides a clearer picture of the benefits received by Chicago residents as a result of the infusion of federal stimulus dollars received over these past

[62] The Electric Focus will be rollout in 19 cities across the country including Chicago.

few years. In addition to the detailed cost benefit analysis, we also made an effort to provide recommendations on further action that we believe has the potential to increase the benefits received in future energy and environment programs.

Finally, this paper is not an inclusive report on all energy and environment stimulus projects for Chicago. As a result, there is ample opportunity to build on the findings of this paper in the future. While the programs analyzed were two of the larger funded programs, it is important to not overlook the programs not analyzed in the paper. We hope that our findings are both expanded to include the remaining Energy and Environmental projects in Chicago funded by ARRA and will also include an updated analysis at each project's completion. Having a thorough and comprehensive ex-post CBA report of all ARRA projects will provide the greatest value for public officials in their attempt to identify the most beneficial future government and philanthropic investments for Chicago residents.

Conclusions

Of the nearly $2.35 billion in American Recovery and Reinvestment Act funding awarded to Cook County[63], we performed cost-benefit analyses on programs that received a total of $1.09 billion. Table 1 reports our results for the seven different categories we studied.

Table 1: Summary of Analysis, 2009 dollars

Area	Grant Analyzed (millions)	Discounted Net Benefits (millions)	Benefit-Cost Ratio
Public Safety	$32.6	$77.6	3.38
Basic Needs	$12.6	$24.6 to $27.7	2.95 to 3.19
Energy	$42.5	$77.2	2.81
Housing	$98.0	$122.4	2.25
Transportation	$151.6	$313.1	2.07
Education	$688.4	-$688.4 to $2,039.7	0 to 3.96
Workforce	$64.1	-$100.4 to $82.5	-.57 to 2.29
TOTAL	**$1,089.8**	**-$173.9 to $2,740.2**	**.84 to 3.51**

Our final results are highly dependent on the program estimates for the largest category, Education, which received over half of all the ARRA funding that we analyzed. If the ARRA funding that prevented teacher layoffs does not have an effect on future student performance, then, as a whole, the net benefits are negative for Cook County. Under the more optimistic case that a lower student-teacher ratio does positively impact future student performance, then there are positive net benefits for ARRA. Under the optimistic assumption, Education has the highest benefit-cost ratio, 3.96. In the pessimistic case for Education, the additional police officers added through Public Safety ARRA grants yields the highest benefit-cost ratio, 3.38. Utilizing conservative assumptions, we find that the job training programs in Workforce Development have the lowest benefit-cost ratio. Because of the potential foregone earnings from participating, it is possible that the benefit-cost ratio is actually negative.

In conclusion, our analysis provides a range for the net benefits of ARRA, from -$173.9 million as the lower estimate to $2,740.2 million as the upper estimate.

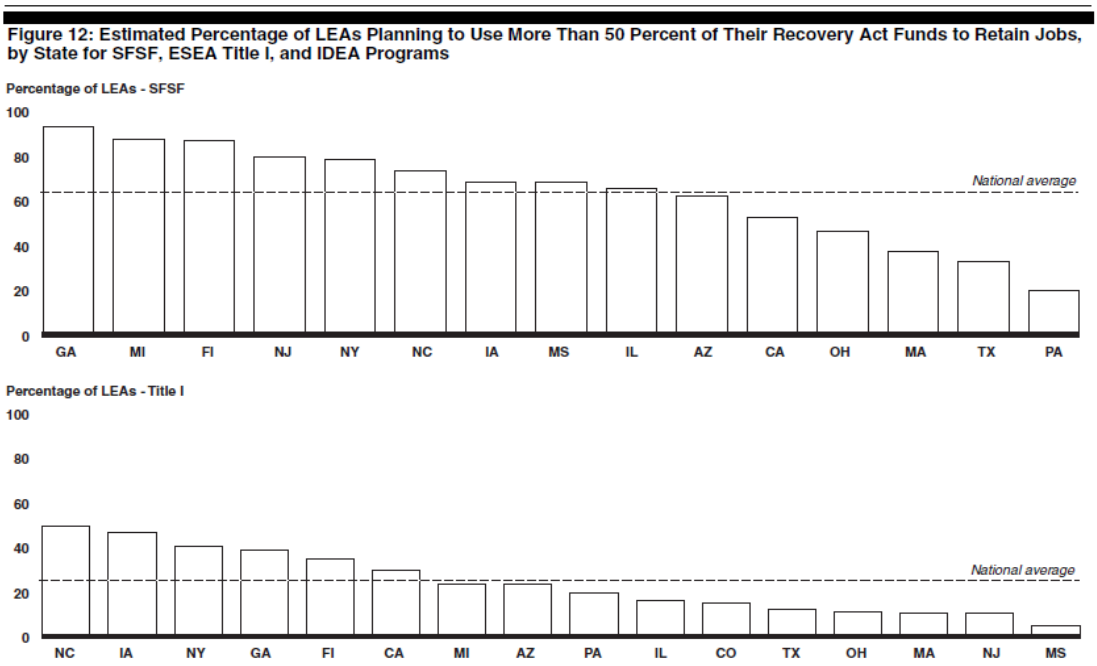
[63] Data available at http://recovery.illinois.gov/default.aspx

Annexes

Chapter 1. Basic Needs

Title I/ SFSF Funds

Annex 1. Teacher retention



Source: Government Accountability Office. "Recovery Act: Status of States' and Localities' Use of Funds To Ensure Accountability." December 2009.

Annex 2. Class Size Impact

Project Star Medium Effect Scenario 1	
Assumptions	**Negative Impact on CPS Students' Lifetime Earnings**
33% decrease in class size over 3 years	$3.9 billion ($9,460 * 409,279)
33% decrease in class size over 2 years	$2.6 billion ($3.9 billion * 2/3)
(Actual timeframe)	
8.98% increase in class size over 2 years	$702.4 million ($2.6 billion * 8.98/33)
(Actual timeframe and class size change)	
Avg. Income Saved Per Student	$1,716 ($702 million/409,279)

Project Star Medium Effect Scenario 2	
33% decrease in class size over 3 years	$3.9 billion ($9,460 * 409,279)
33% decrease in class size over 2 years	$2.6 billion ($3.9 billion * 2/3)
(Actual timeframe)	
11.48% increase in class size over 2 years	$897.94 million ($2.6 billion * 11.48/33)
(Actual timeframe and class size change)	
Avg. Income Saved Per Student	$1,720 ($897 million/409,279)

Project Star Medium Effect Scenario 3	
33% decrease in class size over 3 years	$3.9 billion ($9,460 * 409,279)
33% decrease in class size over 2 years	$2.6 billion ($3.9 billion * 2/3)
(Actual timeframe)	
15.92% increase in class size over 2 years	$1.2 billion ($2.6 billion * 15.92/33)
(Actual timeframe and class size change)	
Avg. Income Saved Per Student	$3,042 ($1.2 billion/409,279)

Project Star High Effect Scenario 1	
Assumptions	**Negative Impact on CPS Students' Lifetime Earnings**
31.8% decrease in class size over 3 years	$8.2 billion ($19,971 * 409,279)
31.8% decrease in class size over 2 years	$5.4 billion ($8.2 billion * 2/3)
(Actual timeframe)	
8.98% increase in class size over 2 years	$1.5 billion ($5.4 billion * 8.98/31.8)
(Actual timeframe and class size change)	
Avg. Income Saved Per Student	$3,760 ($1.5 billion/409,279)

Project Star High Effect Scenario 2	
31.8% decrease in class size over 3 years	$8.2 billion ($19,971 * 409,279)
31.8% decrease in class size over 2 years	$5.4 billion ($8.2 billion * 2/3)
(Actual timeframe)	
11.48% increase in class size over 2 years	$1.97 billion ($5.4 billion * 11.48/31.8)
(Actual timeframe and class size change)	
Avg. Income Saved Per Student	$4,807 ($1.97 billion/409,279)

Project Star High Effect Scenario 3	
31.8% decrease in class size over 3 years	$8.2 billion ($19,971 * 409,279)
31.8% decrease in class size over 2 years	$5.4 billion ($8.2 billion * 2/3)

Homeless Prevention and Rapid Re-Housing

Annex 1: Distribution of Funds for Homeless Prevention and Rapid ReHousing

Distribution of Funds	
Agency	**Award Amount**
Access Living of Metropolitan Chicago	$127,066
Catholic Charities of Chicago	$985,524
Coordinated Advice & Referral Program for Legal Services (CARPLS Legal Aid)	$405,000
Featherfist	$200,000
Heartland Human Care Services Inc	$1,391,569
Housing Opportunities for Women	$360,000
La Casa Norte	$475,670
Lutheran Child & Family Services of Illinois	$155,688
Metropolitan Tenants Organization	$59,087
Spanish Coalition For Housing	$89,350
Trilogy, Inc.	$110,000
Emergency Fund	$24,095,696

Annex 1.

Community Organizations Receiving Funding for Prevention Counseling

Neighborhood Housing Services of Chicago*	Spanish Coalition for Housing*
Partners in Community Building*	Nobel Neighbors
The Resurrection Project*	Polish American Association
Northside Community Federal Credit Union*	Northwest Side Housing Center*
Genesis Housing Development Corporation*	Metropolitan Tenants Organization
Brighton Park Neighborhood Council*	South Austin Coalition Community Council
Lawyers' Committee for Better Housing	Rogers Park Community Development Corporation*
Lawndale Christian Development Corporation	Rogers Park Community Council
South Side Community Federal Credit Union*	Lakeside Community Development Corporation*
Enlace Chicago (formerly Little Village Community Development Corporation)	Legal Assistance Foundation of Metropolitan Chicago*
Kingdom Community*	Chinese American Service League*
Agora Community Services*	Latin United Community Housing Association*

* *HUD approved counseling agencies* (HUD 2011)

Annex 2

Census Tract	Total Foreclosures	Total Owner Occupied Units	Median House Price*	NSP Rehabilitated/ Rebuilt Homes**	Number of Averted Foreclosures Within an 1/8th of a Mile	Avoided Decline in Property Value***
1406	67	901	$335400	51	10	9065862.00
1407	79	984	$324800	60	12	9588096.00
2207	94	919	$335600	71	14	9252492.00
2209	87	744	$326000	66	14	7276320.00
2210	42	441	$295300	32	18	3906819.00
2229	23	180	$241700	17	10	1305180.00
2228	13	35	$295800	10	11	310590.00
2004	123	1009	$293700	93	15	8890299.00
2005	78	416	$319300	59	16	3984864.00
2006	12	196	$292900	9	12	1722252.00
2312	153	677	$217200	116	23	4411332.00
2313	192	891	$232800	145	18	6222744.00
2315	141	538	$189800	107	14	3063372.00
2316	27	212	$201400	20	8	1280904.00
3016	46	523	$236300	35	14	3707547.00
3015	28	413	$225400	21	8	2792706.00
3014	11	89	$222500	8	4	594075.00
6603	46	772	$217300	35	7	5032668.00
6604	46	977	$194000	35	7	5686140.00
6605	46	708	$216400	35	7	4596336.00
6809	32	316	$153900	24	3	486324.00
3811	10	10	$125000	8	12	37500.00
3812	46	327	$370700	35	17	3636567.00
3819	24	185	$248600	18	13	1379730.00
3820	43	357	$349700	33	13	3745287.00
4004	35	114	$275000	26	10	940500.00
4007	26	77	$212500	20	16	490875.00
4008	11	56	$87900	8	2	49224.00
4205	25	116	$228800	19	10	796224.00
4206	32	130	$302300	24	12	1178970.00
4207	95	245	$183700	72	14	1350195.00
6906	11	49	$95000	8	1	46550.00
6907	5	37	$126300	4	4	140193.00
6908	42	493	$154400	32	6	2283576.00
4602	27	366	$118800	20	4	1304424.00
4603	186	878	$148500	141	16	3911490.00
Totals	**2004**	**15,381**	**$ 8,394,700**	**1,515**	**393**	**$ 114,468,227**

* Only of Owner Occupied Units

** Imputed number of houses rebuilt/rehabilitated by the NSP in each tract, assigned proportionate to number of foreclosures

*** 1% decline per foreclosure if less than 3 foreclosures and 3% decline thereafter

Chapter 5. Transportation and Infrastructure

1. ARRA Funding Sources

Annex 1: Summary of ARRA transportation and infrastructure funding by data source and project.

ARRA TRANSPORTATION & INFRASTRUCTURE FUNDING RECONCILIATION TABLE								
Source:	**Illinois Recovery Database**		**FAA AIP & IEPA ARRA***		**Chicago Recovery Partnership Yearly Report**		**City of Chicago Recovery & Dashboard**	
	Funding Program	**Awarded Sum**	**Funding Program**	**Awarded Sum**	**Funding Program**	**Awarded Sum**	**Funding Program**	**Awarded Sum**
Aviation	Chicago O'Hare Noise Mitigation	$ 5,000,000	Chicago O'Hare Noise Mitigation	**$ 5,000,000**				
Aviation			Chicago O'Hare Runway Rehab	**$ 12,294,387**			Runway 10L	$ 5,550,000
							Taxiwide Widening	$ 6,750,000
Aviation			Chicago/Rockford Expand Terminal	**$ 1,052,000**				
Aviation			Chicago/Rockford Runway Rehab	**$ 3,620,000**				
Aviation							Midway Cameras	**$ 2,734,418**
Airport Improvement Program Total =**					**$24,700,805**			
Water	Capitalization for Clean Water	$ 30,725,882						
Water	Capitalization for Drinking Water	$ 9,634,272						
Water	Quality Management Planning	$ 972,996						
Water			Water Main Replacement	**$ 6,051,467**	Water Main Replacement	$ 5,000,000	Water Main Replacement	$ 5,000,000
Water			Sewer Replacement	**$ 10,000,000**			Sewer Replacement	**$ 10,000,000**
Water							Water Metering	$ 5,000,000
Water								
Water								
Water								
Water Maintenace Total =					**$16,051,467**			
Roads	Street Lighting	**$ 2,191,967**						
Roads	Street Resurfacing	**$ 159,820,774**			31 mile Road Repavement	$ 86,000,000		
Roads	Traffic Signals	**$ 576,742**						
Roads	Highway Construction	**$ 90,552,887**						
Roads	Highway Engineering	**$ 7,066,522**						
Roads	Landscaping	**$ 2,447,525**						
Roads	Multi purpose	**$ 265,303**						
Roads	Preliminary Engineering	**$ 4,000,000**						
Roads	Sidewalk	**$ 2,693,605**						
Roads								
Highway Planning & Construction Total =					**$269,615,325**			
Rail	CREATE Rail	$ 11,696,542						
Rail	CREATE Rail	$ 18,815,991					Rail	$ 30,512,533
Rail					High Speed	**$ 133,000,000**	High Speed	$ 133,000,000
Surface Transportation - Discretionary Grants for Capital Investment Total =					**$ 133,000,000**			
CTA/Transit					Dearborn Subway Track	$ 87,804,366	Dearborn Subway Track	**$ 87,800,000**
CTA/Transit					Cermak/Chinatown Station	$ 12,500,000	Cermak/Chinatown Station	**$ 12,500,000**
CTA/Transit					Hybrid Buses	$ 51,500,000	Hybrid Buses	**$ 51,500,000**
CTA/Transit					Kedzie Garage Heating System	$ 5,555,204		
CTA/Transit					Preventive Maintenance	$ 75,200,000		
CTA/Transit					Belmot/Fullerton Canopies	$ 1,913,002	CTA Maintenance	**$ 89,931,915**
CTA/Transit					Oil/Water Separator	$ 2,379,343		
CTA/Transit					Subway Escalators	$ 4,880,000		
CTA/Transit							Transit Security Cameras	**$ 6,944,528**
CTA/Transit Total =					**$248,676,443**			
GRAND TOTAL =					**$692,044,040**			

* Aviation numbers came from Funding for Airport Planning Airport Improvement Program (FAA AIP); water numbers came from Illinois Environmental Protection Agency ARRA funding report (IEPA ARRA). ** Program totals were calculated by including only the values in bold.

2. Hybrid Bus Fuel Cost, Environmental & Health Benefit Calculations

Fuel Cost Savings:

In the baseline scenario, from total fleet miles calculated, we determined the percent share of miles per bus. For example, according to Table 3.2.2, under the ARRA funding scenario there are a total of 208 60-foot hybrid buses, and under the counterfactual there are 150-60 foot hybrid buses. Since there are a total of 2082 buses, the percent share of the hybrid buses is:

ARRA funding:208 60-foot hybrid buses/2082 fleet *100 =9.99% for all 60 foot hybrid buses
Counterfactual:150 60-foot hybrid buses/2082 fleet *100 =7.20% for all 60 foot hybrid buses

Since we assumed that each bus drives the same number of miles per year, using the estimated 71,090,516 miles per year for the CTA bus fleet, for each of the 60-foot hybrid bus fleets we determine:

ARRA funding:7.20% * 71,090,516 miles/year =5,121,795 miles/year for all 60 foot hybrid buses
Counterfactual:9.99% * 71,090,516 miles/year =7,102,223 miles/year for all 60 foot hybrid buses

From miles per year, using the fuel economy from Table 3.2.1, we calculated the difference in fuel consumption between the ARRA funded hybrid buses and the counterfactual. Based on the $3.49 per gallon diesel price, we can then calculate fuel cost savings per year:

ARRA funding:5,121,795 miles/year * gallons/3.7 miles = 1,384,269 gallons/year for all 60 foot hybrid buses
Counterfactual:7,102,223 miles/year * gallons/3.7 miles = 1,919,520 gallons/year for all 60 foot hybrid buses
Difference fuel consumption =1,919,520 - 1,384,269 = 535,251 gallons/year for all 60 foot hybrid buses
Fuel cost savings/year =535,251 gallons/year * $3.49/gallon = $1,868,025/year for all 60 foot hybrid buses

Table 3.2.2 summarizes the differences in fuel consumption for various types of CTA buses. After summing the difference in fuel costs per year for each type of bus, we determine the total discounted fuel cost savings over the fleet's lifetime:

Discounted fuel cost savings for a 15 year lifetime with a 3.2% discount rate for entire fleet=

$$\$239{,}198 \text{ fuel cost/year} + \left[\frac{\left(1-\frac{1}{(1+0.032)^{14}}\right)}{0.032}\right] * \$239{,}198 \text{ fuel cost/year} = \$2{,}904{,}729$$

Overall, the total discounted fuel cost savings from the ARRA funded hybrid buses is **$2,904,729**.

Environmental and Climate Change Benefits:

From Table 3.2.2, in the baseline scenario, the total difference in gallons saved per year between the ARRA funded hybrid buses and the counterfactual is 68,538 gallons diesel saved per year. Using this number, we calculated the yearly savings in fleet emission output for CO_2, NO_x and SO_x:

$$68{,}538 \text{ gallons diesel saved/year} * \frac{2.22 \text{ CO2 lbs}}{\text{gallon}} * \frac{\text{short ton}}{2000 \text{ lbs}} * \frac{\$23.59}{\text{short ton}} = \$1{,}794.42 \text{ } CO_2 \text{ emission savings/year, entire fleet}$$

$$68{,}538 \text{ gallons diesel saved/year} * \frac{0.00256 \text{ NOx lbs}}{\text{gallon}} * \frac{\text{short ton}}{2000 \text{ lbs}} * \frac{\$750}{\text{short ton}} = \$65.80 \text{ NOx emission savings/year, entire fleet}$$

$$68{,}538 \text{ gallons diesel saved/year} * \frac{0.000371 \text{ SOx lbs}}{\text{gallon}} * \frac{\text{short ton}}{2000 \text{ lbs}} * \frac{\$500}{\text{short ton}} = \$6.36 \text{ SOx emission savings/year, entire fleet}$$

Total emissions saved per year, from the ARRA funded hybrid buses is $1866.58 per year. Therefore, the total discounted emission cost savings over the fleet's lifetime is:

Discounted emission savings for a 15 year lifetime with a 3.2% discount rate for entire fleet=

$$\$1866.58/\text{year} + \left[\frac{\left(1 - \frac{1}{(1+0.032)^{14}}\right)}{0.032}\right] * \$1866.58/\text{year} = \$22{,}667$$

Overall, the total discounted environmental and climate change benefits from the ARRA funded hybrid buses is **$22,667**.

Health Benefits:

In the baseline scenario, based on the difference in fuel consumption per year from ARRA funded hybrid buses and the counterfactual, we determine the percent reduction per year of PM emissions. From there, we can estimate the impact on premature deaths:

ARRA funding: $21{,}244{,}472 \text{ gallons diesel consumed} * \frac{0.00111 \text{ PM10 lbs}}{\text{gallon}} =$

23,581 pounds PM10 emissions emitted/year

Counterfactual: $21{,}175{,}933 \text{ gallons diesel consumed} * \frac{0.00111 \text{ PM10 lbs}}{\text{gallon}} =$

23,505 pounds PM10 emissions emitted/year

% change PM from ARRA funding =(ARRA funding – Counterfactual)/(Counterfactual)

$$\% \text{ change PM from ARRA funding} = \frac{(23{,}581 \text{ pounds PM10/year} - 23{,}505 \text{ pounds PM10/year})}{(23{,}505 \text{ pounds PM10/year})}$$

% change PM from ARRA funding =0.32%

Reduction in premature deaths in Cook County due to ARRA funded hybrid buses =

256.65 people/year * 0.32% = 0.8307 people/year

Based on Viscusi (2003), using $8,442,000 as the value of a statistical life over 15 years, the benefit of PM reductions from the hybrid buses is:

Discounted PM savings for a 15 year lifetime with a 3.2% discount rate for entire fleet=

$$\left(\frac{0.8307\ \text{people}}{\text{year}} * \frac{\$8{,}442{,}000}{\text{person}}\right) + \left[\frac{\left(1-\frac{1}{(1+0.032)^{14}}\right)}{0.032}\right] * \left(\frac{0.8307\ \text{people}}{\text{year}} * \frac{\$8{,}442{,}000}{\text{person}}\right) =$$

$$(\$7{,}012{,}624/\text{year}) + \left[\frac{\left(1-\frac{1}{(1+0.032)^{14}}\right)}{0.032}\right] * (\$7{,}012{,}624/\text{year}) = \$89{,}530{,}574$$

Overall, the total discounted health benefits from ARRA funded hybrid buses, is **$89,530,574**.

3. Hybrid Bus Purchase Sensitivity Analysis

Annex 2. Summary of fuel cost savings, environmental and climate change benefits, health benefits and maintenance cost savings from the ARRA funded hybrid buses under all scenarios. Does not include ARRA grant benefits.

FUEL COST, ENVIRONMENTAL, HEALTH AND MAINTENANCE BENEFITS FROM ARRA FUNDED 58 HYBRID BUSES OVER 15 YEARS, DISCOUNTED AT 3.2%											
		TOTAL BENEFITS FROM ARRA FUNDED 58 HYBRID BUSES	FUEL COST SAVINGS	ENVIRONMENTAL AND CLIMATE COST SAVINGS CO2 ($23.59/short ton)	CO2 ($7.26/short ton)	CO2 ($77.11/short ton)	NOX ($750/short ton)	SO2 ($500/short ton)	VALUE EARLY DEATHS AVERTED	MAINTENANCE COST SAVINGS
	INCREASE IN MILES									
	passenger demand increases									
1a	0.25%/year (3.5% over 15 years)	**$ 101,157,731**	$ 2,876,738	$ 21,581	$ 6,640	$ 70,553	$ 791	$ 76	$ 87,313,933	$ 10,944,612
1b	0.5%/year (7% over 15 years)	**$ 101,212,274**	$ 2,930,859	$ 21,987	$ 6,765	$ 71,880	$ 806	$ 78	$ 87,313,933	$ 10,944,612
1c	1%/year (14% over 15 years)	**$ 101,297,066**	$ 3,014,994	$ 22,618	$ 6,959	$ 73,943	$ 829	$ 80	$ 87,313,933	$ 10,944,612
	increase buses (12 additional buses/year)									
1d	increase number of diesel buses	**$ 98,005,638**	$ 2,802,764	$ 21,026	$ 6,469	$ 68,738	$ 771	$ 74	$ 84,236,391	$ 10,944,612
1e	increase number of hybrid buses	**$ 98,297,821**	$ 2,802,764	$ 21,026	$ 6,469	$ 68,738	$ 771	$ 74	$ 84,528,574	$ 10,944,612
	NO CHANGE IN MILES									
2a	passenger demand remains constant	**$ 103,402,582**	$ 2,904,729	$ 21,791	$ 6,705	$ 71,239	$ 799	$ 77	$ 89,530,574	$ 10,944,612
	increase buses (12 additional buses/year)									
2b	increase number of diesel buses	**$ 98,222,799**	$ 3,018,243	$ 22,642	$ 6,967	$ 74,023	$ 830	$ 80	$ 84,236,391	$ 10,944,612
2c	increase number of hybrid buses	**$ 98,514,982**	$ 3,018,243	$ 22,642	$ 6,967	$ 74,023	$ 830	$ 80	$ 84,528,574	$ 10,944,612
2d	no buses retire/replaced	**$ 103,402,582**	$ 2,904,729	$ 21,791	$ 6,705	$ 71,239	$ 799	$ 77	$ 89,530,574	$ 10,944,612
2f	decrease diesel buses (12 buses retired/year)	**$ 104,728,047**	$ 3,018,243	$ 22,642	$ 6,967	$ 74,023	$ 830	$ 80	$ 90,741,639	$ 10,944,612
	diesel prices increase									
2h	$0.10/year ($1.50 over 15 years)	**$ 103,936,437**	$ 3,438,584	$ 21,791	$ 6,705	$ 71,239	$ 799	$ 77	$ 89,530,574	$ 10,944,612
2i	$0.15/year ($2.25 over 15 years)	**$ 104,203,365**	$ 3,705,512	$ 21,791	$ 6,705	$ 71,239	$ 799	$ 77	$ 89,530,574	$ 10,944,612
2j	$0.25/year ($3.75 over 15 years)	**$ 104,737,220**	$ 4,239,367	$ 21,791	$ 6,705	$ 71,239	$ 799	$ 77	$ 89,530,574	$ 10,944,612
	maintenance cost savings decrease/increase									
2k	maintenance cost savings 5%/hybrid bus	**$ 96,106,174**	$ 2,904,729	$ 21,791	$ 6,705	$ 71,239	$ 799	$ 77	$ 89,530,574	$ 3,648,204
2l	maintenance cost savings 10%/hybrid bus	**$ 99,754,378**	$ 2,904,729	$ 21,791	$ 6,705	$ 71,239	$ 799	$ 77	$ 89,530,574	$ 7,296,408
2m	maintenance cost savings 20%/hybrid bus	**$ 107,050,786**	$ 2,904,729	$ 21,791	$ 6,705	$ 71,239	$ 799	$ 77	$ 89,530,574	$ 14,592,816
2n	maintenance cost savings 30%/hybrid bus	**$ 114,347,194**	$ 2,904,729	$ 21,791	$ 6,705	$ 71,239	$ 799	$ 77	$ 89,530,574	$ 21,889,224
	DECREASE IN MILES									
	passenger demand decreases									
3a	0.25%/year (3.5% over 15 years)	**$ 101,052,223**	$ 2,772,047	$ 20,795	$ 6,399	$ 67,985	$ 763	$ 74	$ 87,313,933	$ 10,944,612
3b	0.5%/year (7% over 15 years)	**$ 101,001,203**	$ 2,721,422	$ 20,416	$ 6,282	$ 66,743	$ 749	$ 72	$ 87,313,933	$ 10,944,612
3c	1%/year (14% over 15 years)	**$ 100,902,497**	$ 2,623,480	$ 19,681	$ 6,056	$ 64,341	$ 722	$ 70	$ 87,313,933	$ 10,944,612
3d	decrease diesel buses (12 buses retired/year)	**$ 104,728,047**	$ 3,018,243	$ 22,642	$ 6,967	$ 74,023	$ 830	$ 80	$ 90,741,639	$ 10,944,612

4. Dearborn Subway Sensitivity Analysis

Annex 3. Cost in time days (in hours and based on an $11.95/hour) due to a lag time of two years, during the Dearborn renovation period and for the years following project completion. Shaded dates indicate the time period when the project took place.

LAG 2 YEARS 2011 DEARBORN SUBWAY RENOVATION, WITH 33% SLOW ZONES STARTING DECEMBER 2009				
NUMBER OF PASSENGERS/DAY BASED ON CTA RIDERSHIP REPORT				
WEEKDAY	SATURDAY	SUNDAY		
82500	34599	24821		
TIME PERIOD	% SLOW ZONE	RE-SCALED TIME FOR ONE-WAY TRIP (MINUTES)	TOTAL PASSENGER TIME FOR ONE-WAY TRIP (HOURS)	DISCOUNTED COST OF TIME
April 1 - December 31, 2009	6.8	15.788	4,200,258	$ 49,374,034
December 1-31, 2009	33	22.700	807,800	$ 9,495,685
2010	33	22.700	9,315,334	$ 106,106,346
2011 Project	14.1	17.191	358,362	$ 3,955,354
2011 Project	27.00	22.202	554,415	$ 6,119,247
2011 Project	60.30	35.317	555,561	$ 6,131,899
2011 Project	45.70	29.835	469,324	$ 5,180,076
2011 Project	36.00	26.231	618,948	$ 6,831,518
2011 Project	38.20	27.046	925,275	$ 10,212,547
2011 Project	24.10	21.779	372,542	$ 4,111,865
2011 Project	21.70	20.903	271,334	$ 2,994,800
2011 Project	12.80	17.556	276,163	$ 3,048,092
2011 Project	21.80	20.941	415,803	$ 4,589,342
2011 Project	39.40	27.492	573,106	$ 6,325,549
2011 Project	28.70	24.126	569,269	$ 6,283,193
2011 Project	25.10	23.386	367,875	$ 4,060,353
2011 Project	15.60	19.864	414,090	$ 4,570,435
2011 Project	6.50	16.418	325,998	$ 3,598,137
Remaining 2011	0.00	14.000	1,511,177	$ 16,679,327
2012	0.00	14.000	5,750,998	$ 61,507,314
2013	0.00	14.000	5,750,998	$ 59,600,110
2014	0.00	14.000	5,745,207	$ 57,693,887
2015	0.00	14.000	5,745,207	$ 55,904,929
			TOTAL TIME COST =	$ 494,374,038

Annex 4. Cost in time days (in hours and based on an $11.95/hour) due to a lag time of five years, during the Dearborn renovation period and for the years following project completion. Shaded dates indicate the time period when the project took place.

LAG 5 YEARS 2014 DEARBORN SUBWAY RENOVATION, WITH 33% SLOW ZONES STARTING DECEMBER 2009				
	NUMBER OF PASSENGERS/DAY BASED ON CTA RIDERSHIP REPORT			
	WEEKDAY	SATURDAY	SUNDAY	
	82500	34599	24821	
TIME PERIOD	% SLOW ZONE	RE-SCALED TIME FOR ONE-WAY TRIP (MINUTES)	TOTAL PASSENGER TIME FOR ONE-WAY TRIP (HOURS)	DISCOUNTED COST OF TIME
April 1 - December 31, 2009	6.8	15.788	4,200,258	$ 49,374,034
December 1-31, 2009	33	22.700	807,800	$ 9,495,685
2010	33	22.700	9,315,334	$ 106,106,346
2011	33	22.700	9,297,211	$ 102,616,205
2012	33.00	22.700	9,324,724	$ 99,728,557
2013	33.00	22.700	9,324,724	$ 96,636,198
2014 Project	14.10	17.191	358,362	$ 3,598,705
2014 Project	27.00	22.202	554,415	$ 5,567,483
2014 Project	60.30	35.317	555,561	$ 5,578,995
2014 Project	45.70	29.835	469,324	$ 4,712,995
2014 Project	36.00	26.231	618,948	$ 6,215,529
2014 Project	38.20	27.046	925,275	$ 9,291,696
2014 Project	24.10	21.779	372,542	$ 3,741,104
2014 Project	21.70	20.903	271,334	$ 2,724,763
2014 Project	12.80	17.556	276,163	$ 2,773,250
2014 Project	21.80	20.941	415,803	$ 4,175,527
2014 Project	39.40	27.492	573,106	$ 5,755,183
2014 Project	28.70	24.126	569,269	$ 5,716,646
2014 Project	25.10	23.386	367,875	$ 3,694,237
2014 Project	15.60	19.864	414,090	$ 4,158,325
2014 Project	6.50	16.418	325,998	$ 3,273,698
Remaining 2014	0.00	14.000	1,511,177	$ 15,175,375
2015	0.00	14.000	5,745,207	$ 55,904,929
			TOTAL TIME COST =	$ 606,015,464

Annex 5. Cost in time (in hours and based on an $11.95/hour) due to a lag time of five years, and an increase in rail ridership by 7% starting in 2013, during the Dearborn renovation period and for the years following project completion. Shaded dates indicate the time period when the project took place.

LAG 5 YEARS 2014 DEARBORN SUBWAY RENOVATION, WITH 33% SLOW ZONES STARTING DECEMBER 2009, 7% INCREASE PASSENGER DEMAND STARTING 2013				
		NUMBER OF PASSENGERS/DAY BASED ON CTA RIDERSHIP REPORT		
			WEEKDAY	SATURDAY
			82500	34599
		7% increase in ridership in 2013 =	88275	37021
TIME PERIOD	% SLOW ZONE	RE-SCALED TIME FOR ONE-WAY TRIP (MINUTES)	TOTAL PASSENGER TIME FOR ONE-WAY TRIP (HOURS)	DISCOUNTED COST OF TIME
April 1 - December 31, 2009	3,107	15.788	4,200,258	$ 49,374,034
December 1-31, 2009	15,120	22.700	807,800	$ 9,495,685
2010	15,120	22.700	9,315,334	$ 106,106,346
2011	15,120	22.700	9,297,211	$ 102,616,205
2012	15,120	22.700	9,324,724	$ 99,728,557
2013	15,120	22.700	9,977,466	$ 103,400,843
2014 Project	6,483	17.191	383,448	$ 3,850,619
2014 Project	12,382	22.202	593,224	$ 5,957,213
2014 Project	27,649	35.317	594,451	$ 5,969,530
2014 Project	20,921	29.835	502,177	$ 5,042,910
2014 Project	16,498	26.231	662,275	$ 6,650,623
2014 Project	17,498	27.046	990,045	$ 9,942,124
2014 Project	11,034	21.779	398,621	$ 4,002,985
2014 Project	9,959	20.903	290,328	$ 2,915,500
2014 Project	5,851	17.556	295,494	$ 2,967,381
2014 Project	10,006	20.941	444,909	$ 4,467,818
2014 Project	18,046	27.492	613,224	$ 6,158,053
2014 Project	13,165	24.126	609,118	$ 6,116,818
2014 Project	11,519	23.386	393,627	$ 3,952,837
2014 Project	7,197	19.864	443,076	$ 4,449,413
2014 Project	2,968	16.418	348,818	$ 3,502,859
Remaining 2014	0	14.000	1,616,961	$ 16,237,669
2015	0	14.000	6,147,378	$ 59,818,337
			TOTAL TIME COST =	$ 622,724,360

Annex 6. Cost in time (in hours and based on an $11.95/hour) due to a lag time of five years, and an increase in slow zones to 45% starting in 2013, during the Dearborn renovation period and for the years following project completion. Shaded dates indicate the time period when the project took place.

LAG 5 YEARS 2014 DEARBORN SUBWAY RENOVATION, WITH 33% SLOW ZONES STARTING DECEMBER 2009, 45% SLOW ZONES STARTING 2013				
	NUMBER OF PASSENGERS/DAY BASED ON CTA RIDERSHIP REPORT			
	WEEKDAY	SATURDAY	SUNDAY	
	82500	34599	24821	
TIME PERIOD	% SLOW ZONE	RE-SCALED TIME FOR ONE-WAY TRIP (MINUTES)	TOTAL PASSENGER TIME FOR ONE-WAY TRIP (HOURS)	DISCOUNTED COST OF TIME
April 1 - December 31, 2009	3,107	15.788	4,200,258	$ 49,374,034
December 1-31, 2009	15,120	22.700	807,800	$ 9,495,685
2010	15,120	22.700	9,315,334	$ 106,106,346
2011	15,120	22.700	9,297,211	$ 102,616,205
2012	15,120	22.700	9,324,724	$ 99,728,557
2013	20,618	25.863	10,624,261	$ 110,103,867
2014 Project	6,483	17.191	358,362	$ 3,598,705
2014 Project	12,382	22.202	554,415	$ 5,567,483
2014 Project	27,649	35.317	555,561	$ 5,578,995
2014 Project	20,921	29.835	469,324	$ 4,712,995
2014 Project	16,498	26.231	618,948	$ 6,215,529
2014 Project	17,498	27.046	925,275	$ 9,291,696
2014 Project	11,034	21.779	372,542	$ 3,741,104
2014 Project	9,959	20.903	271,334	$ 2,724,763
2014 Project	5,851	17.556	276,163	$ 2,773,250
2014 Project	10,006	20.941	415,803	$ 4,175,527
2014 Project	18,046	27.492	573,106	$ 5,755,183
2014 Project	13,165	24.126	569,269	$ 5,716,646
2014 Project	11,519	23.386	367,875	$ 3,694,237
2014 Project	7,197	19.864	414,090	$ 4,158,325
2014 Project	2,968	16.418	325,998	$ 3,273,698
Remaining 2014	0	14.000	1,511,177	$ 15,175,375
2015	0	14.000	5,745,207	$ 55,904,929
			TOTAL TIME COST =	$ 619,483,132

Appendix A

Chicago ARRA Project Summary - Environment and Energy Project

-	Low Income Weatherization Program	Chicago Area Alternative Fuels Deployment	Chicago Energy and Efficiency Project	Chicago Region Retrofit Ramp-Up (CR3)	Energy Efficient Appliance Rebate Program (EEARP)	Local Energy Assurance Plan (LEAP)	Chicago Clean Diesel	Green House Gas Reduction	Restoring Chicago's Jobs & Habitats	Total
Grant	Home Weatherization Assistance Program (DOE)	Clean Cities Recovery Act Award	Energy Efficiency and Conservation Block Grant (EECBG)	Energy Efficiency and Conservation Block Grant (EECBG)	Energy Efficient Appliance Rebate Program	Local Energy Assurance Plan Grant	National Clean Diesel Program	DOT Grant	DOA Grant	-
Funding Agency	*Department of Energy (DOE)*	*Department of Energy (DOE)*	*Department of Energy (DOE)*	*Department of Energy (DOE)*	*Department of Energy (DOE)*	*Department of Energy (DOE)*	*Environment Protection Agency (EPA)*	*Department of Transportation (DOT)*	*Department of Agriculture (DOA)*	-
Administrating Agency	Community Economic Development Association (CEDA)	Department of Environment, City of Chicago	City of Chicago	Chicago Metropolitan Agency for Planning (CMAP)	Midwest Energy Efficiency Alliance (MEEA)	City of Chicago	City of Chicago	Chicago Transit Authority	Green Corps Chicago-Calumet	-
ARRA Funding	$90.00	$15.00	$27.60	$25.00	$12.40	$0.3	$1	$1.5	$1.07	***$173.87***
Project Cost	$38.50	$4.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	***$42.5***
Total Net Present Benefit (NPV)	$106.6	$13.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	***$119.7***
Net Benefit	$68.1	$9.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	***$77.2***
Cost Benefit Ratio	2.75	3.28	N/A	N/A	N/A	N/A	N/A	N/A	N/A	***2.81***

** All $ amounts stated in million

Appendix B

Environmental Cost – Carbon Price

Two methods for calculating the environmental benefits of home weatherization were contemplated for this study. The first was to follow the strict market priced approach of carbon. This requires determining the amount of carbon reduced per weatherization activities measured in per tonnage, and pricing this carbon based on the current carbon markets. The Illinois Department of Commerce and Economic Opportunity estimated that a newly weatherized home would reduce carbon emissions by an average of 2.65 metric tons. Unfortunately, a robust market for carbon emissions does not exist in the US as of today, limiting the ability to set a specific price for carbon in tis local context. However, several European nations have taken steps to move toward a system that taxes carbon output. In addition, several economic studies have provided estimates for what they believe the price of carbon would be if a carbon market were to be established in the US. These estimates range from $15-30 per ton, with most reports ranging from $20-$25 per metric ton. Point Carbon, an environmental and energy market research subsidiary of Thomson Reuters, estimates that if the Kerry-Lieberman Carbon bill every passes Congress, the price of carbon would average $26 per metric tons between 2013-2020. Using this estimate, we can derive a financial savings of $69 per year, or $1013 over the 20 year lifespan.

However, carbon reduction is not the only pollutant reduced after the weatherization of a home. Carbon Monoxide, Methane, Sulfer Oxides, and Particulate Matter are additional pollutants that are all lowered by reduced energy use in a home (seen in table below). The DOE report also uses a market valuation approach for their carbon valuation, but also takes these additional pollutants into account in their environmental benefit valuation calculations with estimate of $1086 over 20 years – only slightly higher than the carbon only estimate used above. This is most likely due to the use of a lower market price for carbon in the DOE estimate.

In an effort to remain consistent across program analysis, it was decided to use the standard market valuation method of carbon reduction to capture environmental benefits in our calculations. Given the more robust coverage of also including reductions in oxides, methane, and particular matter captured in the DOE study, the exclusion of these other emission reductions does result in a slightly lower benefit in our measurement. Nevertheless, given both methods provide similar NPV estimates; we feel the benefits of consistency across programs provides justification for the use of the solely carbon reduction and market valuation method described above.

Appendix C
Estimated Station Network Benefits – 10 YR Outlook, 3.2% Discount Rate, 2009 Dollars

Social Benefit of Increased Alternative Fuel Vehicle Adoption Resulting from Increased Refueling Station Network - Sensitivity Analysis				
	Status Quo Benefits	**Increased Alternative Fuel Car Adoption**		
		10%	25%	35%
Annual Growth Rate (***rate of increased AF Vehicle adoption***)	-	0.96%	2.26%	3.05%
Direct Fuel Saving Benefits	$12,353,100	$13,588,410	$15,441,375	$16,676,685
CO2 Emission Reduction Benefits	$766,884	$843,572	$958,605	$1,035,293
Total Benefits	$13,119,984	$14,431,982	$16,399,980	$17,711,978
Estimated Additional Benefit from Increased Refueling Network	-	$1,311,998	$3,279,996	$4,591,994

Bibliographies

Chapter 1. Basic Needs

Education and Head Start

Angrist, Joshua D. and Lavy, Victor. (1999*) Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement*. The Quarterly Journal of Economics. May 1999.

Barnett, W. Steven. (2002) *The Battle Over Head Start: What the Research Shows.* National Institute for Early Education Research. Paper presented September 13, 2002 at a congressional Science and Public Policy briefing on the impact of Head Start. http://nieer.org/resources/research/BattleHeadStart.pdf.

Barnett, W. Steven (2007) *Commentary Benefit-Cost Analysis of Early Childhood Programs*. Social Policy Report. May 2007

Berrueta-Clement, John R., Schweinhart, Lawrence J., Barnett, W. Steven, Epstein, Ann S. and Weikart, David P. (1984) *Changed lives: The Effects of the Perry Preschool Program on Youths Through Age 19.* Monographs of the High/Scope Educational Research Foundation, No. 8.

Breitenstein, Susan. M.; Gross, Deborah.; Ordaz, Irmaleticia; Julion, Wrenwtha; Garvey, Christine and Ridge, Alison (2007) *Promoting Mental Health in Early Childhood Programs Serving Families from Low-income Neighborhoods*. Journal of the American Psychiatric Nurses Association, Vol. 13, pp. 313-320.

Chetty, Raj; Friedman, John; Hilger, Nathaniel; Saez, Emmanuel; Schanzenbach, Diane W. and Yagan, Danny. (2011) *How Does Your Kindergarten Classroom Affect Your Earnings? Evidence From Project Star*. National Bureau of Economic Research. March 2011.

Chicago Public Schools (2007) *Reassignment and Layoff of Regularly Certified and Appointed Tenured Teachers.* Policy Manual, Section 504.2

Chicago Public Schools. (2010) *Stats and Facts*. http://www.cps.edu/About_CPS/At-a-glance/Pages/Stats_and_facts.aspx. [Last accessed on 03/14/2011]

Chicago Public Schools, Human Resources. Full-Time Teacher Salary Schedule - 52 Week Positions" http://www.cps-humanresources.org/Employee/Forms/SalAdm/FTTeachers52.pdf . [Last accessed on 03/14/2011]

Chicago Recovery Partnership. The City of Chicago's ARRA Collaboration with the Chicago Philanthropic Community. (2010) *Final Report.* November 2010.

http://recovery.cityofchicago.org/etc/medialib/stimulus_site/pdf_s/stimulus_scorecard.Par.36329.File.dat/RecoveryPartnershipFinalReportNov2010.pdf. [Last accessed on 03/14/2011]

DeLuca, Stefanie and Rosenblatt, Peter. (2010*). Does Moving to Better Neighborhoods Lead to Better Schooling Opportunities? Parental School Choice in an Experimental Housing Voucher Program.* Teachers College Record, Vol. 112, No. 5, May 2010.

Dye, Richard; McGuire, Therese and McMillen, Daniel. (2005) *Are Property Tax Limitations More Binding Over Time?.* National Tax Journal. Vol. LVII(2), June 2005.

Frisvold, David E. (2007) *Head Start Participation and Childhood Obesity*. Paper Presented at the Allied Social Science Association Meetings, January 2007 Chicago. Cited by Ludwig, Jens and Phillips, Deborah in *Long-Term Effects of Head Start on Low-Income Children*. Ann. N.Y. Academy of Sciences, 1136:257-268 (2008).

Garces, Eliana; Thomas, Thomas, Duncan and Currie, Janet. (2002) *Longer Term Effects of Head Start.* The American Economic Review

Government Accountability Office. (2010) *Recovery Act: Status of States' and Localities' Use of Funds and Efforts to Ensure Accountability*. Report to Congress. December 2010.

Greenwald, Rob, Hedges, Larry V. and Laine, Richard D. (1996) *The Effect of School Resources on Student Achievement*. Review of Educational Research, Vol. 66, No. 3, Autumn 1996, pp. 361-396.

Hanushek, Eric A. (1996) *A More Complete Picture of School Resource Policies*. Review of Educational Research, Vol. 66, No. 3, Autumn 1996, pp. 397-409.

Hanushek, Eric A. (1994) *An Exchange: Part II: Money Might Matter Somewhere: A Response to Hedges, Laine, and Greenwald*. Educational Researcher, Vol. 23, No. 4, May 1994, pp. 5-8.

Hanushek, Eric A. (1997) *Assessing the Effects of School Resources on Student Performance: An Update*. Educational Evaluation and Policy Analysis 19(2), Summer 1997, pp. 141-164.

Hanushek, Eric A. (1986) *The Economics of Schooling: Production and Efficiency in Public Schools.* Journal of Economic Literature, 49(3), September 1986, pp. 1141-1177.

Hanushek, Eric A.; Kain, John F. and Rivkin, Steven G. (1999) *Do Higher Salaries Buy Better Teachers?*. Working Paper 7082, National Bureau of Economic Research, March 1999.

Hanushek, Eric A.; Rivkin, Steven G. and Taylor, Lori L. (1996) *Aggregation and the Estimated Effects of School Resources.* The Review of Economics and Statistics, Vol. 78, No. 4, November 1996, pp. 611-627.

Harvey-Beavis, Owen. (2003) *Performance-Based Rewards for Teachers: A Literature Review*. Workshop of Participating Countries on OECD's Activity Attracting, Developing, and Retaining Effective Teachers, February 2003. http://www.oecd.org/dataoecd/17/47/34077553.pdf.

Hedges, Larry V.; Laine, Richard D. and Greenwald, Rob. (1994) *Money Does Matter Somewhere: A Reply to Hanushek.* Educational Researcher, Vol. 23, No. 4, May 1994, pp. 9-10.

Hutson, Wendell. (2010) *Teacher unions sue CPS over increased class size.* The Chicago Defender: http://www.chicagodefender.com/article-7927-teachers-union-sues-cps-over-increased-class-size.html. 9 June 2010.

Hoxby, Caroline M. (2000) *The Effects of Class Size on Student Achievement: New Evidence From Population Variation*. The Quarterly Journal of Economics. November 2000.

Illinois General Assembly, *School Code, 105 ILCS 5/24‐12*, from Ch. 122, par. 24‐12. http://www.ilga.gov/legislation/ilcs/ilcs4.asp?DocName=010500050HArt.+24&ActID=1005&ChapterID=17&SeqStart=143300000&SeqEnd=146700000 [Last accessed on 05/20/2011]

Kelley, Carolyn; Heneman III, Herbert and Milanowski., Anthony. (2002) *Teacher Motivation and School-Based Performance Rewards*. Education Administration Quarterly Vol 38, No. 3, August 2002, pp. 372-401.

Knudsen, Erik; Heckman, James; Cameron, Judy and Shonkoff, Jack. (2006) *Economic, Neurobiological, and Behavioral Perspectives on Building America's Future Workforce*. Proceedings of the National Academy of Sciences, 103 (27), 10155-10162.

Krueger, Alan B. (2002) *Economic Considerations and Class Size*. National Bureau of Economic Research, Working Paper 8875, April 2002.

Ladd, Helen. (1999) *The Dallas school accountability and incentive program: an evaluation of its impacts on student outcomes.* Economics of Education Review, 18 (1), pp 1-16.

Lee, Valerie E. and Loeb, Susanna. (1995) *Where Do Head Start Attendees End Up? One Reason Why Preschool Effects Fade Out*. Educational Evaluation and Policy Analysis 17(1), pp. 62-82.

Love, J.M., Kisker, E.E., Ross, C., Raikes, H, Constantine, J., Boller, K., Brooks-Gunn, J., Chazan-Cohen, R., Tarullo, L.B., Brady-Smith, C., Fuligni, A.S., Schochet, P.Z., Paulsell, D., Vogel, C. (2005) *The Effectiveness of Early Head Start for 3-Year-Old Children and Their Parents: Lessons for Policies and Programs*. Developmental Psychology 41(6), 885-901.

Ludwig, Jens and Phillips, Deborah. (2007) *The benefits and costs of Head Start*. Social Policy Report. Vol. XXI, No. 3.

Ludwig, Jens and Phillips, Deborah. (2008) *Long-Term Effects of Head Start on Low-Income Children.* Ann. New York Academy of Sciences, 1136:257-268.

Ludwig, Jens, and Bassi, Laurie J. (1999) *The Puzzling Case of School Resources and Student Achievement*. Educational Evaluation and Policy Analysis, Vol. 21, No. 4, Winter 1999, pp. 385-403.

National Association of Child Care Resource & Referral Agencies. (2011) *The cost of Child Care in the State of Illinois* http://www.naccrra.org/publications/naccrra-publications/publications/SFS-Illinois. pdf [Last accessed on 05/20/2011]

Pennington, Jay. *District Expenditures and Student Achievement: A Follow-Up Study*. Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services.

Pike, Gary R.; Smart, John C.; Kuh, George D. and Hayek, John C. (2006) *Educational Expenditures and Student Engagement: When Does Money Matter?*. Research in Higher Education. Vol. 47, No. 7, November 2006, pp. 847-872.

Ramey, Craig T. and Ramey, Sharon L. (2004) *Early Educational Interventions and Intelligence: Implications for Head Star*t. In Zigler, Edward and Styfco, Sally J. (eds.) The Head Start Debates.

Rebell, Michael A.; Wolff, Jessica R. and Yaverbaum, Daniel A. (2010) *Stimulating Equity? A Preliminary Analysis of the Impact of the Federal Stimulus Act on Educational Opportunity*. 2010 Equity Symposium. Teachers College, Columbia University. February 2010.

Reynolds, Arthur J.; Temple, Judy A.; Robertson, Dylan L. and Mann, Emily A. (2002) *Age 21 Cost-Benefit Analysis of the Title I Chicago Child-Parent Centers.* Educational Evaluation and Policy Analysis, Vol. 24, No. 4, Winter 2002, pp. 267-303.

Sloan, Frank A.; Ostermann, Jan; Picone, Gabriel; Conover, Christopher J.; Taylor Jr., Donald H. (2004) *The Price of Smoking*. MIT Press

Sepe, Cristina and Roza, Marguerite. (2010) *The Disproportionate Impact of Seniority-Based Layoffs on Poor, Minority Students.* Center on Reinventing Public Education. University of Washington. May 2010.

Solmon, Lewis C. and Podgursky, Michael. *The Pros and Cons of Performance-Based Compensation*. Milken Family Foundation. http://web.missouri.edu/podgurskym/articles/files/Pros_cons.pdf. [Last accessed on 05/20/2011]

National Forum on Early Childhood Policy and Programs. (2010) *Understanding the Head Start Impact Study*. http://www.nhsa.org/files/static_page_files/0BF4EB6E-1D09-3519-ADBFF989BFF11535/2-10ForumEvalScienceBrief_HeadStart.pdf. [Last accessed on 05/20/2011]

U.S. Department of Education. (2010 a) *Department of Education Recovery Plan* http://www.recovery.gov/Transparency/agency/Recovery%20Plans/ED%20Recovery%20Act%20Plan%20-%20June%202010.pdf. [Last accessed on 05/20/2011]

U.S. Department of Education. (2010 b) *Fact sheet outlining the impact of U.S. Department of Education Recovery Act funding on Illinois*. http://www2.ed.gov/policy/gen/leg/recovery/state-fact-sheets/illinois.doc . [Last accessed on 05/20/2011]

U.S. Department of Education. (2010 c) *Teacher Incentive Fund.* http://www2.ed.gov/programs/teacherincentive/index.html . [Last accessed on 05/20/2011]

U.S. Department of Education, National Center for Education Statistics (NCES). (2010) *Table A-17-1. Median Annual Earnings and Percentage of Full-time, Full-year Wage and Salary Workers Ages 25–34, by Educational Attainment, Sex, and Race/ethnicity: Selected Years, 1980–2008*. http://nces.ed.gov/programs/coe/2010/section2/table-er2-1.asp [Last accessed on 05/17/2011]

U.S. Department of Health and Human Services, Administration for Children and Families, Office of Head Start. (2010 a) *About the Office of Head Start.* http://www.acf.hhs.gov/programs/ohs/about/index.html#prog_desc. [Last accessed on 05/20/2011]

U.S. Department of Health and Human Services, Administration for Children and Families, Office of Head Start. (2010 b*) Head Start Program Fact Sheet, Fiscal Year 2010*. http://www.acf.hhs.gov/programs/ohs/about/fy2010.html. [Last accessed on 05/20/2011]

Westat. (2010). *Head Start Impact Study Final Report*. Contracted by the U.S. Department of Health and Human Services, Administration for Children and Families, Office of Planning, Research and Evaluation, January 2010.

http://www.acf.hhs.gov/programs/opre/hs/impact_study/reports/impact_study/executive_summary_final.pdf .

Homeless Prevention and Rapid Re-Housing

Abt Associates Inc, Khadduri, Jill, Leopold, Josh, Sokol, Brian, Spellman, Brooke. *Costs Associated With First-Time Homelessness For Families and Individuals*. U.S. Department of Housing and Urban Development. March 2010. http://www.huduser.org/publications/pdf/Costs_Homeless.pdf

Burt, Martha, Dave Pollack, Abby Sosland, Kelly Mikelson, Elizabeth Drapa, Kristy Greenwalt, Patrick Sharkey. *Evaluation for Continuums of Care for Homeless People: Final Report*. The Urban Institute. May 2002.

Burt, Martha R., Carol Pearson, and Ann Elizabeth Montgomery. *Strategies for Preventing Homelessness*. Washington, DC: U.S. Department of Housing and Urban Development. 2005.

Culhane, Dennis, Stephen Metraux, and Thomas Byrne. "A Prevention Centered Approach to Homeless Assistance: A Paradigm Shift?" 13 January 2010: http://www.csb.org/files/docs/News/Newsletter/2010/Prevention_centered_approach_paper_11310_formatted.pdf.

Diamond, Pamela and Steven B. Schneed, Lives in the Shadows: Some of the Costs and Consequences of a "Non-System" of Care. Hogg Foundation for Mental Health, University of Texas, Austin, TX, 1991. 6Slevin, Peter, Life After Prison: Lack of Services Has High Price. The Washington Post, April 24, 2000.

Gelberg, Lillian, Lawrence Linn, and Barbara Leake. "Mental Health, Alcohol and Drug Use, and Criminal History Among Homeless Adults." *American Journal of Psychiatry*. 145 (1998): 191-195.

Jones, Kristine, Paul Colson, Mark Holter, Shang Lin, Elie Valencia, Ezra Susser, and Richard Jed Wyatt. "Cost-Effectiveness of Critical Time Intervention to Reduce Homelessness Among Persons With Mental Illness." *Psychiatric Services*. Vol. 54, No. 6. June 2003.

Regional Review of the American Recovery and Reinvestment Act for Northeastern Illinois. *A Regional Response to the American Recovery and Reinvestment Act*. October 2010.

Rosenheck, Robert. "Cost-Effectiveness of Services for Mentally Ill Homeless People: The Application of Research to Policy and Practice." *American Journal of Psychiatry*. 157 (2000):1563-1570.

Rosenheck, Robert, Wesley Kasprow, Linda Frisman, Wen Liu-Mares. “Cost Effectiveness of Supported Housing for Homeless Persons With Mental Illness.” *Archives of General Psychiatry*. Vol. 60. September 2003.

Salit S.A., Kuhn E.M., Hartz A.J., Vu J.M., Mosso A.L. Hospitalization costs associated with homelessness in New York City. *New England Journal of Medicine* 1998; 338: 1734-1740.

Chapter 2. Workforce Development

Bloom, Howard S., Orr, Larry L., Bell, Stephen H., Cave, George, Doolittle, Fred, Lin, Winston and Johannes M. Bos. 1997. “The Benefits and Costs of JTPA Title II-A Programs: Key Findings from the National Job Training Partnership Act Study”. *The Journal of Human Resources* 32(3):549-76.

Heckman, James J., LaLonde, Robert J., and Jeffrey A. Smith. “The Economics and Econometrics of Active Labor Market Programs.” 1999. In *Handbook of Labor Economics Volume 3,* edited by A. Aschenfelter and D. Card.

Heinrich, Carolyn J., Mueser, Peter R., and Kenneth R. Troske. 2008. “Workforce Investment Act Net Impact Evaluation: Final Report. Report to U.S. Department of Labor. Columbia, Maryland: IMPAQ International, LLC.

Heinrich, Carolyn J., Mueser, Peter R., Troske, Kenneth R., Jeon, Kyung-Seong, Kahvecioglu, Daver. 2009. “New Estimates of Public Employment and Training Program Net Impacts: A non-experimental evaluation of the Workforce Investment Act Program.” Report to U.S. Department of Labor. Columbia, Maryland: IMPAQ International, LLC.

Workforce Boards of Metropolitan Chicago. 2009. Metropolitan Chicago Region ARRA Summer Youth Employment Programs. Workforce Indicator Report 05. <http://www.workforceboardsmetrochicago.org/publications/>

Workforce Boards of Metropolitan Chicago. 2010. Status Report: Use of American Recovery and Reinvestment Act Funds Expanding the Workforce Investment Act Program. Workforce Indicator Report 09. <http://www.workforceboards metrochicago.org/publications/>

Hollenbeck, Kevin M. 2009. Return on Investment Analyses of a Selected Set of Workforce System Programs in Indiana. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Hollenbeck, Kevin M. 2009. Workforce Investment Act (WIA) Net Impacts and Rate of Return. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Hollenbeck, Kevin M. and Wei-Jang Huang. 2006. Net Impact and Benefit-Cost Estimates of the Workforce Development System in Washington State. Technical Report No. TR06-020. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Hollenbeck, Kevin M. and Wei-Jang Huang. 2008. Workforce Program Performance Indicators for The Commonwealth of Virginia. Technical Report No. 08-024. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Illinois Department of Commerce and Economic Opportunity. 2007. WIA Policy Letter No. 07-PL-35. <http://www.commerce.state.il.us/dceo/Bureaus/Workforce_Development/Resources/WIA+Policy+Letters.htm>

Smith, Jeffrey A. 2000. "A Critical Survey of Empirical Methods for Evaluating Active Labor Market Programs." *Swiss Journal of Economics and Statistics* 136(3): 247-268.

U.S. Census Bureau. 2008. Current Population Survey: Annual Social and Economic Supplement. < http://pubdb3.census.gov/macro/032008/perinc/new03_003.htm > and < http://pubdb3.census.gov/macro/032008/perinc/new03_006.htm >.

Chapter 3. Public Safety

Cohen, M. and Piquero, A. (2009). "New Evidence on the Monetary Value of Saving a High Risk Youth." Journal of Quantitative Criminology 25(1): 25.

Cohen, M. A. (1998). "The Monetary Value of Saving a High-Risk Youth." Journal of Quantitative Criminology 14(1): 5.

Cohen, M. A., Rust, R. T. et al. (2004). "Willingness-to-Pay for Crime Control Programs*." Criminology 42(1): 89.

Corman, H. and Mocan, H. N. (2000) A Time-Series Analysis of Crime, Deterrence, and Drug Abuse in New York City. The American Economic Review 90(3):584-604.

Di Tella, R. and Schargrodsky, E. (2004). Do Police Reduce Crime? Estimates Using the Allocation of Police Forces After a Terrorist Attack. The American Economic Review 94(1): 115-133.

Donohue, J.J. (2007) Assessing the relative benefits of incarceration: the overall change over the previous decades and the benefits on the margin. Yale Law School and NBER Working Paper (October)

Evans, W. N. and Owens, E. G. (2007). COPS and crime. Journal of Public Economics 91(1-2): 181.

Heaton, P. (2010) Hidden in Plain Sight: What Cost-of-Crime Research Can Tell Us About Investing in Police. RAND Corporation Occasional Paper

Klick, J. and Tabarrok, A. (2004) Using Terror Alert Levels to Estimate the Effect of Police on Crime. American Law and Economics Working Paper 38

Levitt, S.D. (2002) Using Electoral Cycles in Police Hiring to Estimate the Effects of Police on Crime: Reply. The American Economic Review 92(4): 1244-1250

Levitt, S. D. (1997) Using Electoral Cycles in Police Hiring to Estimate Effect of Police on Crime. The American Economic Review 87(3): 270-90.

McCollister, K. E., French, M. T. et al. (2010). The cost of crime to society: New crime-specific estimates for policy and program evaluation. Drug and Alcohol Dependence 108(1-2): 98.

Miller, T. R. (1990). The Plausible Range for the Value of Life: Red Herrings Among the Mackerel. Journal of Forensic Economics 3(3): 17-39.

Miller, T. R., Cohen, M. A., and Wiersema, B. (1996). Victim Costs and Consequences: A New Look. Rockville, Maryland. US Department of Justice

Viscusi, W. K. and Aldy, J. E. (2003). The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World. Journal of Risk and Uncertainty 27(1): 5.

Websites

All websites retrieved March 2011

Chicago Police Department

Chicago Police Department 2009 Annual Report
https://portal.chicagopolice.org/portal/page/portal/ClearPath/News/09AR.pdf

Superintendent's Blog 501
http://soa.chicagopolice.org/roller/blog501/entry/vehicle_and_technology_update_januar
y

Tech Update 2007
https://portal.chicagopolice.org/portal/page/portal/ClearPath/News/Department%20Publi
cations/TechUpdate07.pdf

City of Chicago

City Of Chicago::Fire Stations
http://www.cityofchicago.org/city/en/depts/cfd/dataset/fire_stations.html

City of Chicago Recovery Website

Chicago-Cook ARRA JAG Budget Worksheet Narrative
http://recovery.cityofchicago.org/etc/medialib/stimulus_site/pdf_s.Par.51442.File.dat/CH
ICAGO-COOK%20ARRA%20JAG%20Budget%20Worksheet%20Narrative.pdf

City of Chicago Recovery and Reinvestment | Public Safety
http://recovery.cityofchicago.org/stimulus/en/funding_categories/public_safety.html

Federal Recovery Website
Project Summary
http://www.recovery.gov/Transparency/RecipientReportedData/pages/RecipientProjectSummary508.aspx?AwardIDSUR=47840andqtr=2009Q4

Illinois State Police
Section V – Law Enforcement Employment Information
http://www.isp.state.il.us/docs/cii/cii08/cii08_Section_V_Pg213_to_236.pdf

National Transportation Safety Board
The Benefits of Vehicle-Mounted Video Recording Systems
http://www.ntsb.gov/events/symp_rec/proceedings/authors/scaman.htm

Police Online.com
In-Car Cameras Make ILL. Cops 'Uncomfortable'
http://www.policeone.com/police-products/communications/articles/2031129-In-car-cameras-make-Ill-cops-uncomfortable/

Stimulus Watch
ARRA Rail and Transit Security Grant Program Capital Projects
http://stimuluswatch.org/2.0/awards/view/9448/american-recovery-and-reinvestment-act-rail-and-transit-security-grant-program-capital-projects

Transit Chicago
CTA Uses Surveillance Network to Improve Customer Safety
http://www.transitchicago.com/news/default.aspx?Archive=bxlvgltdtandpg=8andArticleId=2564
CTA 2008 Budget
http://www.transitchicago.com/assets/1/board_presentations/07102008budget.pdf

USAT Corporation
The Impact of Video Evidence on Modern Policing
http://www.usatcorp.com/images/products/panasonic/IACP-%20Impact%20of%20Video%20Evidence%20on%20Modern%20Policing.pdf

US Census Department
U.S. Census Bureau Delivers Illinois' 2010 Census Population Totals
http://2010.census.gov/news/releases/operations/cb11-cn31.html

Chapter 4. Housing

Apgar, William C.; Duda, Mark; Gorey, Rochelle Nawrocki. (2005) *The Municipal Cost of Foreclosures: A Chicago Case Study.* Homeownership Preservation Foundation. Housing Finance Policy Research Paper Number 2005-1. February 27, 2005.

California Reinvestment Coalition (CRC), Community Reinvestment Association of North Carolina (CRA-NC), Empire Justice Center, Massachusetts Affordable Housing Alliance (MAHA), Neighborhood Economic Development Advocacy Project (NEDAP), Ohio Fair Lending Coalition, and Woodstock Institute. (2011) *Paying More for the American Dream.* Woodstock Institute 2011.

Center for Responsible Lending. (2009) *Soaring Spillover: Accelerating Foreclosures to Cost Neighbors $502 Billion in 2009 Alone; 69.5 Million Homes Lose $7,200 on Average*. CRL Issue Paper. May 2009.

Center for Responsible Lending. (2008) *Subprime Spillover: Foreclosures Cost Neighbors $202 Billion; 40.6 Million Homes Lose $5.000 on Average*. CRL Issue Paper. January 2008.

Chicago Neighborhood Stabilization Program (2010) *Chicago wins $98 million in second round of NSP funding to acquire foreclosed properties*, by John McCarron Published: January 20, 2010, http://www.chicagonsp.org/news/159, [Last Accessed 05/20/2011].

Chicago Sun Times (2011) *Case-Shiller index shows broad drop* by Francine Knowles [Feb, 12, 2011] http://www.suntimes.com/business/3484826-420/percent-prices-area-chicago-metropolitan.html [Last accessed on 05/20/2011]

City of Chicago. (2011a) *The Neighborhood Stabilization Program* http://www.cityofchicago.org/city/en/depts/dcd/supp_info/neighborhood_stabilizationprogram.html [Last accessed on 05/20/2011]

City of Chicago. (2011b) *Housing* http://www.cityofchicago.org/city/en/progs/hous.html [Last accessed on 05/20/2011]

Core Logic. (2011*) CoreLogic Reports Shadow Inventory Declines Slightly, However, Nine Months' Worth of Supply Remains* http://www.corelogic.com/About-Us/News/CoreLogic-Reports-Shadow-Inventory-Declines-Slightly-However-Nine-Months-Worth-of-Supply-Remains.aspx

Federal Bank of Chicago. (2010) *Addressing the Impact of the Foreclosure Crisis.* Federal Reserve Mortgage Outreach and Research Efforts (MORE).

Frame, W. Scott. (2010) *Estimating the Effect of Mortgage Foreclosures on Nearby Property Values: A Critical Review of the Literature.* Federal Reserve Bank of Atlanta. Economic Review. Number 3, 2010.

Gass, Anne. (2009) *Responsible Approaches to Neighborhood Stabilization: Case Studies in Action*. ABG Consulting. Neighborhood Reinvestment Corporation. 2009.

Gass, Anne. (2010) *Implementing the Neighborhood Stabilization Program (NSP): Community Stabilization in the NeighborWorks Network.* ABG Consulting. 2010.

Harding, John P.; Rosenblatt, Eric and Yao, Vincent W. (2009) *The contagion effect of foreclosed properties*, Journal of Urban Economics, 2009, vol. 66, issue 3, pages 164-178

Heaton, Paul. (2010) Center on Quality Policing. *Hidden in Plain Sight: What Cost-of-Crime Research Can Tell Us About Investing in Police.* Issues in Policing. Rand. 2010.

Hirad, Abdighani and Zorn, Peter M. (2001) *A Little Knowledge Is a Good Thing: Empirical Evidence of the Effectiveness of Pre-Purchase Homeownership Counseling.* Freddie Mac. May 22, 2001.

Hornburg, Steven P. (2004) *Strengthening the Case for Homeownership Counseling: Moving Beyond "A Little Bit of Knowledge."* Joint Center for Housing Studies, Harvard University. December 2004.

HUD (2011) HUD Approved Housing Counseling Agencies http://www.hud.gov/offices/hsg/sfh/hcc/hcs.cfm?webListAction=search&searchstate=IL[Last accessed on 05/20/2011]

Immergluck, Dan and Smith, Geoff. (2006a) *The External Costs of Foreclosure: The Impact of Single-Family Mortgage Foreclosures on Property Values*. Fannie Mae Foundation. Housing Policy Debate. Volume 17. 2006.

Immergluck, Dan and Smith, Geoff. (2006b) *The Impact of Single-family Mortgage Foreclosures on Neighborhood Crime.* Housing Studies, Vol. 21, No. 6, 851–866, November 2006.

Kingsley, G. Thomas; Smith, Robin and Price, David. (2009) *The Impacts of Foreclosures on Families and Communities*. The Urban Institute. Report Prepared for the Open Society Institute. May 2009.

Levi, Ivan. (2009) *Stabilizing Neighborhoods Impacted by Concentrated Foreclosures: Scattered-Site Rental Housing Challenges and Opportunities*. The Edward M. Gramlich Fellowship in Community Development. October 2009.

Mallach, Alan. (2009) *Stabilizing Communitites: A Federal Response to the Secondary Impacts of the Foreclosure Crisis*. Brookings Institute. February 2009.

Marketwatch (2010) Home prices fall in 0.2% in December, Case Schiller says, http://www.marketwatch.com/story/home-prices-fall-02-in-december-case-shiller-2010-02-23 [Last accessed on 05/20/2011]

Mayer, Neil; Tatian, Peter A.; Temkin, Kenneth; Calhoun, Charles A. (2010) *National Foreclosure Mitigation Counseling Program Evaluation: Preliminary Analysis of*

Program Effects. The Urban Institute. Prepared for NeighborWorks America. September 2010.

McGilvray, Margaret. (2000) AHECI – Homeowner Education and Counseling Cost and Benefits Study Data Availability Survey Report. PowerPoint presentation at the Research Institute for Housing America's 2000 Conference on Housing Opportunity ("Homeowner Education and Counseling: Creating an Industry to Expand Housing Opportunity"), April 6, 2010, Washington, DC. (http://www.housingamerica.org/downloads/MMcGilvray.ppt).

Muro, Mark; Bradley, Jennifer; Berube, Alan; Puentes, Robert; Rahman, Sarah and Reamer, Andrew. (2009) *Metro Potential in ARRA: An Early Assessment of the American Recovery and Reinvestment Act.* Metropolitan Policy Program. March 2009.

Neighborhood Housing Services of Chicago. (2010) *NHS Foreclosure Prevention Activities and Results in FY 2010.* July 2010.

Neighbourhood Housing Services (2011a) Foreclosure Prevention http://www.nhschicago.org/site/topnav_landing/category/foreclosure_prevention [Last accessed on 05/20/2011]

Neighbourhood Housing Services (2011b) Foreclosure Workshop http://www.nhschicago.org/site/3C/category/foreclosure_workshop

Pennington-Cross, Anthony. (2004) *The Value of Foreclosed Property*. Federal Reserve Bank of St. Louis. Working Paper 2004-022A. September 2004.

Quercia, Roberto G.; Cowan, Spencer M.; Moreno, Ana B. (2005) *The Cost-effectiveness of Community-based Foreclosure Prevention*. Family Housing Fund. December 8, 2005.

RealtyTrac (2010) *U.S. Foreclosure Market Report* in Mandelman Matters, *U.S. Breaks Housing Price Decline Record Set During Great Depression* http://mandelman.ml-implode.com/2011/01/5138/ [Last accessed on 05/20/2011]

RealtyTrac (2011) http://www.realtytrac.com/trendcenter/ [Last accessed on 05/20/2011]

Smith, Geoff and Duda, Sarah. (2011a) *Left Behind: Troubled Foreclosed Properties and Servicer Accountability in Chicago.* Woodstock Institute. January 2011.

Smith, Geoff and Duda, Sarah. (2011b) *Bridging the Gap II Examining Trends and Patterns of Personal Bankruptcy in Cook County's Communities of Color.* Woodstock Institute. May 2011.

Strauss, Leslie and Phillips, Sue. (1997) *Housing Counseling in Rural America*. Prepared by the Housing Assistance Council. January 1997.

Woodstock Institute (2011) Chicago City and Regional Foreclosure Activity Fourth

Quarter 2010. Woodstock Institute Record Information Services.

Woodstock Institute Factbook http://www.woodstockinst.org/factbook/ [Last accessed on 05/20/2011]

Chapter 5. Transportation and Infrastructure

American Society of Civil Engineers. "The Dearborn Subway Track Renewal Project." *American Society of Civil Engineers*. American Society of Civil Engineers -- Illinois Section, n.d. Web. 14 Apr. 2011. <www.isasce.org/web/technical/Structural_Files/SEI%2020110112.pdf>.

Archondo-Callao, Rodrigo. "HDM-4: Bituminous Roads Deterioration." Highway Development and Management Conference. Presentation, n.d. Web. 17 March 2011. <www.worldbank.org>.

Beecher, Janice. "Water Pricing Primer for the Great Lakes Region." The Alliance for Water Efficiency, December 2010. Web. 18 March 2011. <http://www.allianceforwaterefficiency.org/WorkArea/showcontent.aspx?id=5604>.

Beyer-Clow, Lenore et al. "Before the Wells Run Dry: Ensuring Sustainable Water Supplies for Illinois". Metropolitan Planning Council, November 2009. Web. 18 March 2011. <http://www.metroplanning.org/uploads/cms/documents/before_the_wells_run_dry.pdf>.

Blonn, Jennifer et al. "Transport 2020 Bus Rapid Transit: A Cost Benefit Analysis" December 4, 2006. Web. 18 March 2011. <http://legistar.cityofmadison.com/attachments/9ff645fd-99b3-42b9-9f19-fee1f734bb54.pdf>.

Bureau of Labor Statistics (BLS). "Occupational Employment and Wages in Chicago-Naperville-Joliet." *U.S. Bureau of Labor Statistics*. U.S. Bureau of Labor Statistics, n.d. Web. 19 May 2011. <http://www.bls.gov/ro5/oeschi.htm>.

Bureau of Transportation Statistics (BLS). "Homepage." US Bureau of Transportation, n.d. Web. 18 March 2011. <http://www.bts.gov/>.

Chicago Metropolitan Agency for Planning. "Water 2050 Northeastern Illinois Regional Water Supply/Demand Plan." Chicago Metropolitan Agency for Planning, March 2010. Web. 18 March 2011. <http://www.cmap.illinois.gov/water-2050>.

Chicago Transit Authority (CTA). "Annual Ridership Report." Chicago Transit Authority, 24 Jan. 2011. Web. <http://www.transitchicago.com/assets/1/ridership_reports/2010-Annual.pdf>.

City of Chicago (a). “City of Chicago Recovery and Reinvestment: Transportation and Infrastructure”. City of Chicago, n.d. Web. 8 Jan. 2011. <http://recovery.cityofchicago.org/stimulus/en/funding_categories/transportation.html>.

City of Chicago (b). “City Receives First Competitive Grant From Federal Stimulus Plan”. City of Chicago, 2009. Web. 12 May, 2011. <http://www.cityofchicago.org/city/en/depts/doa/provdrs/omp/news/2009/mar/city_receives_firstcompetitivegrantfromfederalstimulusplan.htm>.

City of Chicago (c). "Chicago Recovery Partnership." *City of Chicago*. Version Twelve-Month Report. City of Chicago, n.d. Web. 18 May 2011. <www.cityofchicago.org/content/dam/city/progs/recovery_and_reinvestment/stimulusreports/RecoveryPartnershipFinalReport>.

Chicago Transit Authority (CTA (a)). "2010 Annual Ridership Report." *Chicago Transit Authority*, 24 Jan. 2011. Web. <http://www.transitchicago.com/assets/1/ridership_reports/2010-Annual.pdf>.

Chicago Transit Authority (CTA (b)). "'L' (Rail) System Slow Zone Maps." *Chicago Transit Authority*, Apr. 2011. Web. 16 May 2011. <http://www.transitchicago.com/news_initiatives/slowzonemaps.aspx>.

Chicago Transit Authority (CTA (c)). “2002 Annual Budget Summary.” *Chicago Transit Authority*, 2002. Web. 10 April 2011. <http://www.transitchicago.com/assets/1/finance_budget/2002sum.pdf>.

Chicago Transit Authority (CTA (d)). “Proposed 2003 Annual Budget Summary.” *Chicago Transit Authority*, 2003. Web. 10 April 2011. ,http://www.transitchicago.com/assets/1/finance_budget/2003sum.pdf>.

Chicago Transit Authority (CTA (e)). “2004 Annual Budget Summary.” *Chicago Transit Authority*, 2004. Web. 10 April 2011. , < http://www.transitchicago.com/assets/1/finance_budget/2004sum.pdf>.

Chicago Transit Authority (CTA (f)). “2005 Annual Budget Summary.” *Chicago Transit Authority*, 2005. Web. 10 April 2011. ,http://www.transitchicago.com/assets/1/finance_budget/2005sum.pdf>.

Chicago Transit Authority (CTA (g)). “2006 Annual Budget Summary.” *Chicago Transit Authority*, 2006. Web. 10 April 2011. ,http://www.transitchicago.com/assets/1/finance_budget/2006sum.pdf>.

Chicago Transit Authority (CTA (h)). “2010 Budget Recommendations.” *Chicago Transit Authority*, 2010. Web. 10 April 2011. <http://www.transitchicago.com/assets/1/finance_budget/2010budgetbook.pdf>.

Energy Information Administration (EIA). “Chapter 3: Vehicle Miles Traveled”. U.S. Energy Information Administration, Feb. 2002. Web. 18 March, 2011. <http://www.eia.doe.gov/emeu/rtecs/chapter3.html>.

Energy Information Administration (EIA). "Weekly On-Highway Retail Diesel Prices." U.S. Energy Information Administration, 25 Apr. 2011. Web. 15 May 2011. <http://www.eia.doe.gov/oog/info/wohdp/diesel.asp>.

Environmental and Energy Study Institute (EESI). “Hybrid Buses Costs and Benefits”. Environmental and Energy Study Institute, 2007. Web 19 March 2011. <http://www.eesi.org/files/eesi_hybrid_bus_032007.pdf>.

Environmental Protection Agency (EPA (a)). “Local Trends in Particulate Matter Levels.” Environmental Protection Agency, n.d. Web. 18 March 2011. <http://www.epa.gov/airtrends/pm.html#pmloc>.

Environmental Protection Agency (EPA (b)). “Control and Mitigation of Drinking Water Losses in Distribution Systems.” Environmental Protection Agency, Nov. 2010. Web. 18 March 2011. <http://www.allianceforwaterefficiency.org/uploadedFiles/Resource_Center/Library/water_loss/EPA-Water-Loss-Control-November-2010.pdf>.

Environmental Protection Agency (EPA (c)). “Particulate Matter.” Environmental Protection Agency, n.d. Web. 18 March 2011. <http://www.epa.gov/air/particlepollution/>.

Environmental Protection Agency (EPA (d)). “Diesel Exhaust In the United States”. Environmental Protection Agency, June 2003. Web. 18 March 2011. <www.epa.gov/cleandiesel/documents/420f03022.pdf>.

Esworthy, R. and J. E. McCarthy. “Air Quality: EPA’s Proposed Changes to the Particulate Matter (PM) Standard”. Congressional Research Service, 26 Jan. 2006. Web. 15 Apr.2011. <http://www.policyarchive.org/handle/10207/bitstreams/2727.pdf>.

Eugene Airport. “Eugene Airport Runway Rehabilitation Project.” Eugene Airport, 16 March 2010. Web. 8 Apr. 2011. <http://www.eugene-or.gov/portal/server.pt/gateway/PTARGS_0_2_357804_0_0_18/Eugene%20Airport%20Runway%20Rehab%20Project%202010.pdf>.

Federal Aviation Administration (FAA). “FAA Airport Benefit-Cost Analysis Guidance”. Federal Aviation Administration, 15 Dec. 1999. Web 4 Apr. 2011. <http://www.faa.gov/airports/central/aip/benefit_cost/#process>.

Federal Aviation Administration (FAA). “O’Hare Modernization Program Business Case”. Federal Aviation Administration, 20 Sept. 2005. Web. 2 Apr. 2011.

<http://www.faa.gov/airports/airport_development/omp/Planning/media/OMPbusCaseFinal.pdf>

Federal Aviation Administration (FAA (a)). “FFA Airport Improvement Program (AIP) and American Recovery and Reinvestment Act (ARRA) Projects: Fiscal Years 2005-09”. Federal Aviation Commission, 2011. Web. 18 March 2011. <http://www.faa.gov/airports/aip/grant_histories/airport_projects/>.

Federal Aviation Administration (FAA (b)). “Revised Departmental Guidance: Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses”. Federal Aviation Administration, Feb.2008. Web. 18 March 2011. <http://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/Revised%20Value%20Of%20Life%20Guidance%20Feburary%202008.pdf>.

Federal Department of Transportation (DOT). “FY 2009 New Starts and Small Starts Evaluation and Rating Process.” Federal Department of Transportation, 20 July 2010. Web. 18 March 2011. <http://fta.dot.gov/planning/newstarts/planning_environment_9063.html#IIA_Project_Justification_Rating>.

Federal Railroad Administration (FRA). “High Speed Intercity Passenger Rail Program.” Federal Railroad Administration, n.d. Web. 18 March 2011. <http://www.fra.dot.gov/rpd/passenger/2243.shtml>.

Federal Transit Administration (FTA). “New Starts Shift Policy Q&A Document”. Federal Transit Administration, 13 Jan. 2010. Web. 18 March 2011. <http://www.fta.dot.gov/about/about_FTA_11065.html>.

Gazis, D. C. Traffic Theory. Boston, 2002. Kluwer Academic Publishers.

Hoffer, Stefan et al. “Economics Analysis of Investment and Regulatory Decisions-Revised Guide”. Federal Aviation Administration, 1998. Web. 18 March 2011. <http://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/ECONOMIC.pdf>.

Hill, Rod. "Particulate Matter Air Quality Management Plan." Town of Truckee, Memorandum from Rod Hill, Air Pollution Control Officer, Northern Sierra Air Quality Management District, 25 Mar. 1996. Web. <http://www.townoftruckee.com/Modules/ShowDocument.aspx?documentid=1637>.

Illinois Environmental Protection Agency (IL EPA). “Illinois EPA ARRA Stimulus Recipients”. Illinois Environmental Protection Agency, n.d. Web. 17 Feb. 2011. <http://dataservices.epa.illinois.gov/stimulusallocation/Default.aspx>.

Litman, Todd. “Evaluating Public Transit Benefits and Costs: Best Practices Guidebook.” Victoria Transport Policy Institute, 11 March, 2011. Web. 17 March 2011. <http://www.vtpi.org/tranben.pdf>.

Mayer, P., Towler, E. and William B. DeOreo. “National Multiple Family Submetering and Allocation Billing Program Study.” Alliance for Water Efficiency, 2004. Web. 18 March 2011 <http://www.nmhc.org/Content/ServeContent.cfm?ContentItemID=3242>.

Morgan, Curtis et al. “Potential Development of an Intercity Passenger Transit System in Texas- Report on Tasks 1-5.” Texas Transportation Institute, May 2009. Web. 18 March 2011. <http://tti.tamu.edu/documents/0-5930-1.pdf>.

Muellner, Terrance. "Chicago Transit Authority Presentation on Alternative Fuels." Chicago Transit Authority, 20 Apr. 2009. Web. 15 May 2011. <http://www.afv2009.com/documents/TerranceMuellner042209.pdf>.

Nordhaus, William. “The Stern Review on the Economics of Climate Change.” March 2007. Web. 12 March 2011. <http://nordhaus.econ.yale.edu/stern_050307.pdf>.

Point Carbon. “Globally Carbon Markets Gain One Percent in Value from 2009 to 2010.” Point Carbon, 2011. Web. 14 March, 2011. <http://www.pointcarbon.com/aboutus/pressroom/pressreleases/1.1496966>.

San Francisco Metropolitan Transit Agency (MTA). “Hybrid Bus.” San Francisco Metropolitan Transit Agency, n.d. Web. 18 March 2011. <http://www.sfmta.com/cms/mfleet/hybrids.htm>.

State of Illinois. “Download Illinois Recovery Data”. State of Illinois, 2011. Web. 18 March 2011.

Steele, Brian. “Stimulus-funded street resurfacing program a success; more work coming 2010”. City of Chicago, 4 Jan. 2010. Web. 2 March 2011. <http://www.cityofchicago.org/city/en/depts/cdot/provdrs/street/news/2010/jan/stimulus-funded_streetresurfacingcontinues.html>.

Stern, Nicholas. “The Economics of Climate Change: The Stern Review.” Cambridge University Press, 2007.

Texas Department of Transportation (TX DOT). “Roadway Design Manual Revised May 2010.” Texas Department of Transportation, 2010. Web. 18 March 2011. < http://onlinemanuals.txdot.gov/txdotmanuals/rdw/rdw.pdf>.

Sturm, R., Thorton J. “Water Loss Control in North America: More Cost Effective Than Consumer Side Conservation- Why Wouldn’t You Do It?.” Alliance for Water Efficiency, n.d. Web. 18 March 2011. <www.allianceforwaterefficiency.org/>.

Todorovich, Petra and Yoav Hagler. “High-Speed Rail in America.” America 2050, Jan. 2011. Web. 18 March 2011. <http://www.america2050.org/2011/01/high-speed-rail-in-america.html>.

U.S. Census Bureau. "Cook County QuickFacts from the US Census Bureau." *State and County QuickFacts*. U.S Census Bureau, 4 Nov. 2010. Web. 15 May 2011. <http://quickfacts.census.gov/qfd/states/17/17031.html>.

U. S. Army Corps of Engineers. "Lake Michigan Diversion Accounting: Water Year 2005 Report". U.S. Army Corps of Engineers, n.d. Web. 18 March 2011. <http://155.79.114.198/divacct/2005_Annual/wy03_annual.pdf>.

Victoria Transport Policy Institute. "Transportation Cost and Benefit Analysis Techniques, Estimates and Implications." Victoria Transport Policy Institute, 2nd edition, Jan. 2009. Web. 18 March 2011. <http://www.vtpi.org/tca/>.

Viscusi, W. K. and Aldy, J. E. "The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World." *Journal of Risk and Uncertainty* 27(1), 2003.

Welman, S., Williams A. and H. Hecthman. "Calculating Delay Propagation Multipliers for Cost Benefit Analysis." Federal Aviation Administration, 2010. Web. 18 March 2011. <http://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/faabca.pdf >.

World Health Organization (WHO). "WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide: Global Update 2005". World Health Organization, 2006. Web. 18 March 2011. <http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf>.

Chapter 6. Energy and the Environment

Brinckerhoff, Parsons. "Alternative Fuels Corridor Economic Feasibility Study". Prepared for Washington State Department of Transportation. January 23, 2009. http://www.wsdot.wa.gov/NR/rdonlyres/5C14E610-713A-4600-A88D-C567AF49D096/0/AltFuelsFinalReport.pdf

Eisenberg, Joel F. "*Weatherization Assistance Program Technical Memorandum Background Data and Statistics.*" Oak Ridge National Laboratory on behalf of U.S. Dept. of Energy. March 2010.

Li, Shanjun, Joshua Linn, Elisheba Spiller, and Christopher Timmins, "*Evaluating 'Cash for Clunkers': Program Effect on Vehicle Sales and Cost-Effectiveness,*" April 2010. SSRN Working Paper No. 1594924.

Sallee, James M. "The Taxation of Fuel Economy" University of Chicago. October 5, 2010. NBER Working Paper.

Schweitzer, Martin and Bruce Tonn. "*Non- Energy Benefits from the Weatherization Assistance Program: A summary of Findings from Recent Literature.*" Oak Ridge National Laboratory on behalf of U.S. Dept. of Energy. April 2002

"Carbon to Average $26/ton in Early years of US Emission Trading System". Point Carbon press release. Published May 19, 2010. *http://www.pointcarbon.com/aboutus/pressroom/pressreleases/1.1444891*

Werpy, M. Rood, D. Santini, A. Burnham, and M. Mintz *"Natural Gas Vehicles: Status, Barriers, and Opportunities"*. Energy Systems Division. Argonne National Laboratory – Center for Transportation Research, Energy Systems Divison. August 2010.