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Measuring the Economic Impact of High Speed Rail Construction for California and the Central Valley Region

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REPORT 18-08

MEASURING THE ECONOMIC IMPACT OF HIGH-SPEED RAIL CONSTRUCTION FOR CALIFORNIA AND THE CENTRAL VALLEY REGION

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Cover Photo: California High-Speed Rail Authority. “Construction of the Fresno River Viaduct in January 2016. The bridge is the first permanent structure being constructed as part of California High-Speed Rail. The BNSF Railway bridge is visible in the background.” Accessed July 27, 2018 from https://commons.wikimedia.org/wiki/File:Fresno_River_Viaduct_construction_2016.jpg.

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EXECUTIVE SUMMARY

The nation's first high-speed rail project is under construction in California's Central Valley as of the date of this report. This research analyzes the immediate economic impacts, focused on employment and spending generated by California High-Speed Rail (HSR) Construction Package 1 (CP1) in the Central Valley and the rest of California. The authors use a two-pronged approach that combines original economic analysis and modeling with case study vignettes that explore the economic impacts through the lens of a sample of businesses and individuals directly impacted by this phase of HSR development.

CP1 is the focus of this research. In addition to the significant design-build (DB) contract, which amounts to \$1.28 billion, additional expenditures included in this analysis that enable construction, such as right-of-way (RoW) acquisition, planning, project management, and utility relocation, bring total spending to \$2.654 billion for this first major segment of the HSR project. This spending falls mainly in two areas: (1) construction (71%), and (2) expenditures related to right-of-way acquisition (23%). A detailed accounting of CP1-related spending is provided in Chapter III.

The economic forecasting and policy analysis tool used for this research was developed by Regional Economic Models, Inc. (REMI). The REMI Model enables users to predict impacts on a regional economy under different scenarios. This analysis tool falls within the same broad category of input-output and general equilibrium models as other tools such as the RIMS II (Regional Input-Output Modeling System) Model, developed by the Bureau of Economic Analysis, and the IMPLAN (Impact Analysis for Planning) Model. A variety of alternative economic scenarios were considered, detailed in Chapter IV, and employment estimates calculated.

Overall, the economic analysis suggests that CP1-related spending (forecasted through to 2019) will lead to more than 31,500 additional jobs (both part-time and full-time) by the year 2029. Growth is concentrated in Fresno County, with the number of additional jobs estimated at more than 15,500. The analysis considers job growth across a number of alternative scenarios, converting the raw jobs estimates to *full-time equivalent job-years*.

Under the most conservative HSR spending scenario considered, over the 15-year period evaluated, more than 25,000 *full-time equivalent job-years* are created. This amount to 14,900 jobs per billion (real) dollars of spending, or a cost of approximately \$67,200 per job-year.

The REMI Model suggests that direct, indirect, and induced employment are all significant for various regions in the model. The direct and induced effects are greatest in the regions which are the focus of spending, i.e. Madera and Fresno Counties, while the indirect employment effects are greatest in Merced and the Rest-of-California. In terms of occupations, the main effects are in construction-related occupations and management.

While the detailed economic modeling conducted for this research provides a big picture understanding of the employment and related economic impacts of the HSR project within the Central Valley and the rest of California, it is also important to recognize that this project

is about individual people and individual companies and the impact to them. In Chapter VI, a series of case study vignettes are presented that explore, how the HSR project has impacted a sample of individual companies in the Central Valley, either through their involvement working directly on the project, or as businesses that have been relocated. These vignettes do not cover the complete range of impacts across the wide range of companies and individuals touched by HSR in the Central Valley but do serve to provide supplementary contextual understanding of the aggregate estimates produced through the REMI analysis.

Overall, this research documents that the spending associated with CP1-related activities in California's Central Valley has led, and will lead to, significant economic impacts through increased employment compared to a baseline policy scenario that assume no additional HSR spending. Conservatively, more than 25,000 full-time equivalent job-years will be created at a total cost-per-job of approximately \$67,200. This falls within the typical range of estimates for other major transportation infrastructure investment projects identified in the literature, which range from \$41,000 to \$92,000 per job-year.¹ During conversations with several companies working on the HSR project, interviewees described how the contracts often led to additional hiring and provided examples of some of the additional spillover economic impacts that occurred. Interviews with a small number of relocated firms provided insight into some of the challenges faced during the process, as well as how the HSR contract has led to new opportunities.

I. INTRODUCTION

The objective of this research is to determine how dollars spent on the California High-Speed Rail (HSR) project associated with Construction Package 1 (CP1) impact the Central Valley and California using a two-pronged approach that combines original economic analysis and modeling with case study vignettes that explore the economic impacts through the lens of a several businesses and individuals directly impacted by this phase of HSR development.

BACKGROUND ON THE HSR PROJECT AND CP1

High-speed train travel currently does not exist in California, but planning for it began decades ago.² The governmental agency today known as the California High-Speed Rail Authority (CHSRA) was created by an act of legislature in 1996.³ In 2008, 52.7% of California voters approved Proposition 1A, which authorized the state of California to sell \$9.95 billion in bonds to fund the project. This funding was supplemented in 2009 with money from the American Recovery and Reinvestment Act (ARRA); CHSRA "...secured \$3.3 billion in ARRA funds and other funds made available through federal appropriations and grants for planning and environmental work, as well as construction."⁴

Figure 1 shows the entire California High-Speed Rail project which is planned to be built in two phases (with interim steps and segments along the way). Phase 1 refers to stations between San Francisco and Anaheim; the segments traversing the route from Sacramento to Merced, and Los Angeles to San Diego, are to be built as part of the second phase.



Figure 1. California High-Speed Rail (HSR) Proposed Statewide Alignment as of May 2016

Source: CHSRA, 2016. "California High-Speed Rail Statewide System." Accessed December 12, 2017 from http://www.hsr.ca.gov/docs/newsroom/maps/Statewide_System_2016.pdf

The CHSRA project is divided for development purposes into the following sections:⁵

1. San Francisco to San Jose
2. San Jose to Merced
3. Merced to Sacramento

4. Merced to Fresno
 - a. Central Valley Wye (the piece of infrastructure that is the turning point for trains travelling between Sacramento and San José and points south)
5. Fresno to Bakersfield
 - a. Locally Generated Alternative (the F Street Alignment in Bakersfield)
6. Bakersfield to Palmdale
7. Palmdale to Burbank
8. Burbank to Los Angeles
9. Los Angeles to Anaheim
10. Los Angeles to San Diego

The first construction as part of Phase 1 is approximately 119 miles, is located in the Central Valley, between Madera and Kern counties, and is divided into separate Construction Packages, denoted CP1, CP2-3, CP4, and CP5.⁶ Figure 2 shows the areas of these packages.

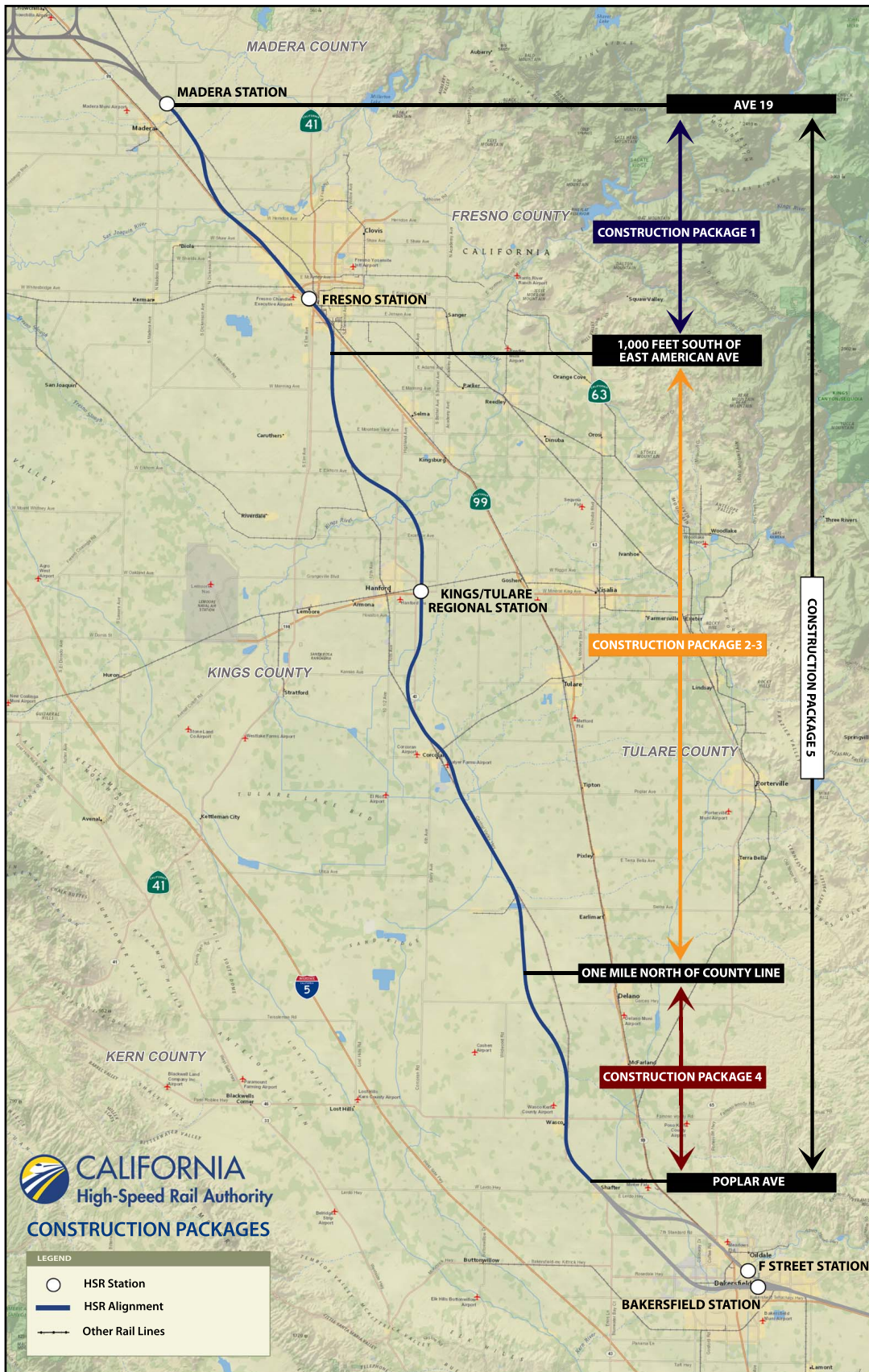


Figure 2. CHSRA Construction Packages 1 through 5

Source: CHSRA, n.d. "Construction Packages." Accessed December 12, 2017 from <https://www.hsr.ca.gov/Programs/Construction/index.html>

CP1 is the focus of this research. In addition to the significant design-build (DB) contract, which amounts to \$1.28 billion, additional expenditures that enable construction, such as right-of-way (RoW) acquisition, planning, project management, utility relocation, among other costs, bring total spending to \$2.654 billion for this first major phase of development on the HSR project and were included in this analysis.

CP1 is located in both the Merced-Fresno and Fresno-Bakersfield sections. Approximately 85% of the length of CP1 is in the Merced-Fresno section. Figure 3, below, shows the CP1 area in detail. CP1 is located in both Fresno and Madera counties, which are separated by the San Joaquin river. Of the 34.54 miles of CP1, 16.47 miles (48%) are in Fresno County and 18.06 miles (52%) are in Madera County. These geographic details are important, because the economic analysis performed using the REMI Model (described in detail in Chapter IV) employs county-level input data and generates county-level forecasts.

The specific construction activities in CP1 include, among others: 12 grade separations, 2 viaducts, 1 tunnel, and the major river crossing over the San Joaquin River. Although stations in Madera and Fresno are currently planned for the Merced-Fresno section, construction of the physical stations is beyond the scope of CP1. In addition, CP1 does not involve actual laying of rail track as part of the construction activities so those activities are not considered in this analysis.

The Merced-Fresno segment received environmental clearance from the Federal Railroad Administration (FRA) in 2012.⁷ The design-build contract, discussed in detail in Chapter III, is the contract for the large majority of all construction work for CP1 and began August 16, 2013. The project's official groundbreaking in Fresno took place on January 6, 2015.⁸



Figure 3. CHRSA Construction Package 1

Source: CHSRA, 2016. "Construction Package 1." Accessed December 12, 2017 from http://www.hsr.ca.gov/docs/programs/construction/CP1_Map.pdf

OVERVIEW OF REPORT

The rest of this report is structured as follows. Firstly, the authors present a brief review of the existing literature on economic impact analysis, particularly focused on large infrastructure projects, and a summary of past California HSR economic impact studies. In Chapter III, the researchers provide a detailed description and accounting of the contracts and expenditures (actual and forecast) associated with CP1. This information provides the data inputs for the economic modeling in Chapter IV. A detailed discussion of the modeling results is contained in Chapter V. Chapter VI presents several case study vignettes that explore specific experiences from a selection of firms contracted to work on CP1 as well as several firms that were relocated due to HSR construction. Conclusions are presented in Chapter VII. Supplemental materials with detailed information regarding the accounting for CP1 and the economic modeling are available online at: <http://transweb.sjsu.edu/research/1627>.

II. A REVIEW OF THE LITERATURE ON ECONOMIC IMPACT ANALYSIS

This brief chapter is intended to provide context for the interpretation of the economic modeling presented in Chapters IV and V, as well as background for the case studies developed for this research and discussed in Chapter VI. In addition, this chapter describes the most recent Economic Impact Analysis (EIA) that was conducted by the CHSRA, comparing and contrasting it with the present study.

THE ECONOMIC IMPACT OF INFRASTRUCTURE INVESTMENT

Many academic studies over the last several decades have examined the effect of spending on variables such as jobs and wages. In particular, the ARRA (also known as the Recovery Act) provided the impetus for a large body of empirical work that aims to statistically estimate the impacts of stimulus spending on the macro economy or on regional economies.⁹ There are at least 37 academic articles published between 2010 and 2017 that examine the impacts of the Recovery Act. These studies provide background context regarding methods for conducting similar studies, such as the present one, that look at the number of jobs created through major infrastructure spending and the broader impacts to the local, regional, and/or national economy.¹⁰

Several studies sought to estimate the cost per job created via the Recovery Act. A 2014 Council of Economic Advisers study concluded that “the Recovery Act, by itself, saved or created about 6 million job-years, where a job-year is defined as one full-time job for one year.”¹¹ Regarding this specific jobs estimate, Dupor and Mekhari note that “[t]his translates into a cost of \$140,000 per job...”¹² Another source of information that looks at the number of jobs created by this major government investment are the reports prepared by the Congressional Budget Office as a requirement of the Recovery Act.¹³ Dupor and Mekhari also review a number of related studies in their analysis, summarized as follows:¹⁴

Wilson (2012)...finds that increasing employment by one worker at the one-year mark of the Act cost \$125,000. Conley and Dupor (2013) ...find that, over the first two years following the Act’s passage, it cost \$202,000 to create a job lasting one year. Chodorow-Reich et al. (2012) ...find that during the first 18 months of the program, this component of the Act increased employment at a cost of \$26,000 per job-year.

Thus, studies that have estimated the cost per job resulting from ARRA have found a wide range of estimates. This diversity of estimates can be attributed to a variety of reasons including the time period examined, how the researchers defined the specific investment inputs (i.e. the actual dollar value assigned to the project), how the researchers defined and identified the number of jobs, as well as the modeling and estimation methods used. It is therefore important, when conducted this type of economic analysis and when reviewing previous studies, to carefully document the assumptions made as part of the analysis.

QUALITATIVE APPROACHES TO ECONOMIC ANALYSIS

Chapter VI of this report examines the economic impacts of HSR spending using qualitative methods. The research team reviewed the scholarly literature for examples of previously published qualitative economic impact analysis but found that very few studies have employed qualitative methods to assess jobs created or other economic impacts resulting from infrastructure spending. A possible reason for this gap is that, unlike more traditional quantitative economic modeling, asking interviewees or survey respondents to report how many jobs were created as a direct result of their activity (or similar questions) is at least partly subjective and will contain an element of estimation. Precisely estimating how many additional job-hours are directly attributable to a specific amount of grant, contract or loan spending is not a simple task. Even if the respondent is asked to calculate the direct jobs impact only (as opposed to the direct, indirect, and induced impacts as well), the multiplicity of causes leading to the ultimate hiring of a new employee may make an accurate answer difficult to identify. The approach the authors take here is to use interviews to illustrate the economic analysis conducted in Chapter IV, rather than generate data for the analysis.

Dupor employed survey data in estimating jobs from a portion of the ARRA.¹⁵ This was data gathered as required by law by the Recovery Accountability and Transparency Board (RATB). Recipients of some ARRA funds were required to submit quarterly reports describing the job impacts and other aspects of their grant. Dupor and Mehkari used the narrative descriptions of jobs created from the RATB reports and also examined the impacts of higher wages, as well as jobs created/saved as a result of the Recovery Act.¹⁶ The qualitative evidence they present is a very rare example of economic analysis of survey data in an EIA. A passage from this report illustrates their qualitative analysis:

The responses give hundreds of examples of projects being implemented using, at least in part, overtime workers. For example, a \$26,000 grant to a Wisconsin Indian Tribe administered by the Department of Justice explains that during 2011 Q1: “This grant does not pay for additional jobs. It pays for overtime for the existing staff for community activities.”¹⁷

As evident from this example, qualitative approaches can highlight specific examples of how financial investments are actually used by the recipient—in this case, not to hire additional staff, but to pay for overtime for existing staff. This nuance is often masked in quantitative approaches that use modeling tools such as RIMS II (Regional Input-Output Modeling System), IMPLAN (Impact Analysis for Planning), or REMI.¹⁸

While the use of survey data in EIA is rare, the preceding discussion highlights a few examples, particularly focused on ARRA, which inform the original qualitative economic impact analysis carried out by the research team in the present report.

CHSRA ECONOMIC IMPACT ANALYSIS

The remainder of this chapter reviews the recent EIA carried out by WSP (formerly Parsons-Brinckerhoff), the Rail Delivery Partner for CHSRA. WSP employees act as an extension of staff under a long-term contract with CHSRA.

WSP prepared an Economic Impact Technical Memorandum, which is available on the CHSRA website.¹⁹ The Memorandum reports that “from July 2006 through June 2016, the Authority invested over \$2.3 billion in planning and construction of the high-speed rail system. Overall, this investment has supported 19,900 to 23,600 job-years of employment (including direct, indirect, and induced impacts) and generated \$3.5 to \$4.1 billion in total economic activity...”²⁰ This impact translates into a cost-per job range of \$97,458 to \$115,578.

The WSP study also reviews several EIA studies related to California HSR, as well as several EIAs of other types of transportation infrastructure spending. The report notes that capital spending on other major transportation projects (not CHSRA spending) resulted in estimates of job creation, from four separate studies, of 24,000, 11,400, 10,900 and 11,900 job-years per \$1 billion spent.²¹ These figures translate to cost-per-job figures of \$41,667, \$87,719, \$91,743 and \$84,033, respectively, which fall within the lower range of estimates from the empirical studies focused on Recovery Act spending discussed above. Compared to the cost-per-job range for the HSR project discussed in the above paragraph, these costs are lower, although not dramatically so compared to the upper end of the estimates.

There are several differences between the WSP study and the analysis carried out in the present report. First, the two studies use different modeling tools. The WSP analysis utilizes RIMS II and IMPLAN models, whereas the present study utilizes the REMI model. More importantly, however, is the timeframe under consideration in both studies. The WSP analysis examines the impact of actual spending retroactively through June 2016, while the present study examines actual and forecast spending from 2015 through 2019 and traces the impacts of spending through 2029. A third notable difference is the WSP analysis considered spending across the entire CHSRA system, while the present study’s focus is on CP1 only. As such, the results of each study should not be directly compared, but should be viewed in light of these different approaches.

Finally, it is important to note that the WSP study excluded right-of-way (RoW) payments, noting that “payments to property owners for land acquisition [are] considered an economic transfer and is excluded from the economic impact analysis.”²² However, the present study includes RoW payments for land acquisition are simply another cost. As discussed in Chapter III, these land acquisition payments are large, whether measured in magnitude or as a proportion of total CHSRA spending. The RoW payments, like payments to vendors, impact spending in the regions we study.

III. DESCRIPTION AND ACCOUNTING OF HIGH-SPEED RAIL CONSTRUCTION IN THE CENTRAL VALLEY

This chapter provides an overview of spending on the California HSR project, also describing the specific spending data used in Chapter IV for economic modeling. This chapter and related appendices also detail specific information about the contractors working in the CP1 area and the categories of spending. This discussion and the economic modeling will set the stage for the case studies in Chapter VI.

Determining which spending to include and which to exclude as part of the CP1 area required analysis and judgment on the part of the research team. The following sections describe the approach taken to this key question. While for some categories (such as preliminary engineering), most of this spending has already occurred, for other categories, including the main construction contract, only a minority of the forecasted spending had occurred.²³

CHSRA SPENDING OVERVIEW

This research uses four primary sources of data:

1. *Total Project Expenditures with Forecasts* (TPEF) reports;
2. *Funding Contribution Plan* (FCP) reports;
3. *Contracts and Expenditures* (C&E) reports; and
4. Master contracts file provided by CHSRA.

The authors provide detail first on the TPEF reports, followed by a discussion of the other three types of data.

Total Project Expenditures with Forecasts (TPEF) Reports

The *Total Project Expenditures with Forecasts* (TPEF) reports provide a top-down view of the HSR project. For the purposes of this research, the version used was from the July 2017 Finance and Audit Committee Meeting.

TPEF lists annual expenditures by three main categories of spending:

1. Administration;
2. Project Development; and
3. Construction.

Figure 4 plots annual expenditures for the three main categories, from fiscal year 2006–07 to 2016–17. As shown in the figure, construction spending ramps up significantly in FY2014–15. By FY2016–17, construction spending across all active construction packages and other components was nearly a billion dollars.²⁴

The three spending categories of administration, project development, and construction are further subdivided in the TPEF report. Administration is divided into communications and administration, although communications is a very small percentage of this category, and project development is subdivided based on geographic segment. Figure 5 below plots the annual project development spending for four geographic segments in Phase 1.

Unlike project development, the TPEF report does not differentiate construction spending by segment, and the published amounts combine spending across all construction packages. However, the TPEF report does differentiate between some categories related to construction. Real Property Acquisition and Design-Build Contract Work were by far the two largest categories of spending in recent years. Figure 6 shows spending for these two categories, as well as six other areas of construction spending.²⁵

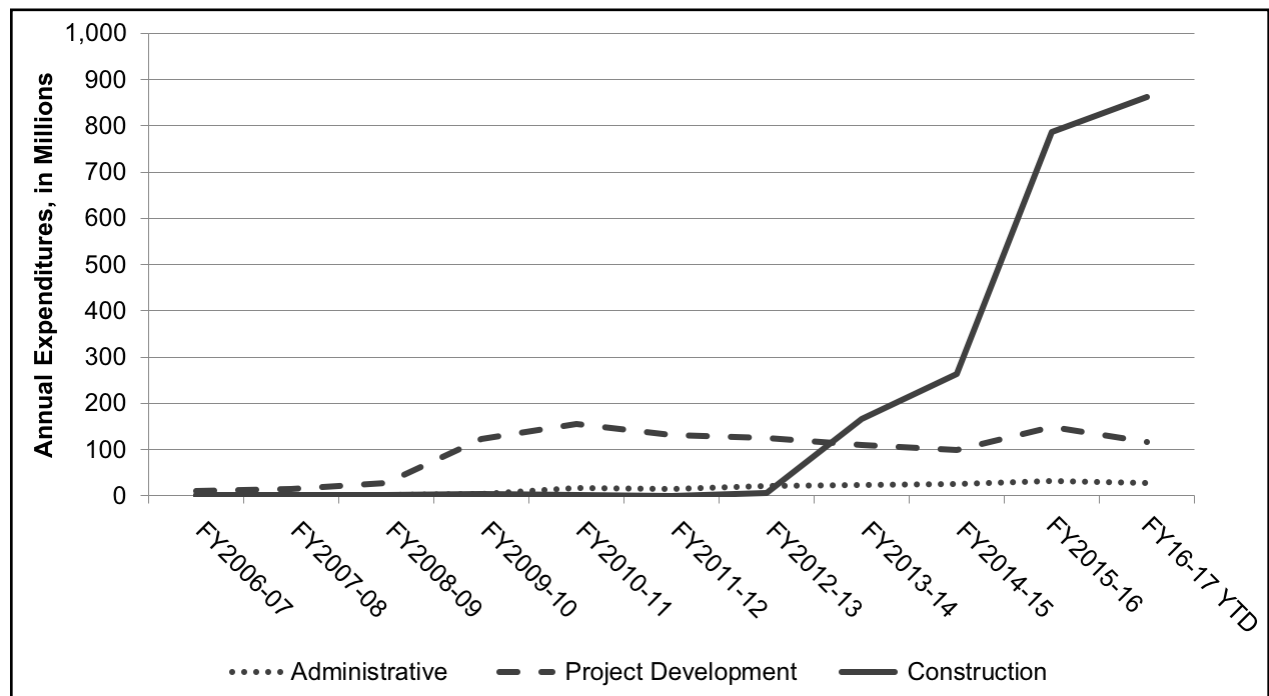


Figure 4. Annual CHSRA Spending by Main Categories in the TPEF Report, FY 2006/7 through FY 2016/17

Source: CHSRA, 2017. "Total Project Expenditures with Forecasts, July 2017." Accessed December 12, 2017 from http://www.hsr.ca.gov/docs/brdmeetings/2017/brdmtg_071817_FA_Total_Project_Expenditures_with_Forecasts.pdf

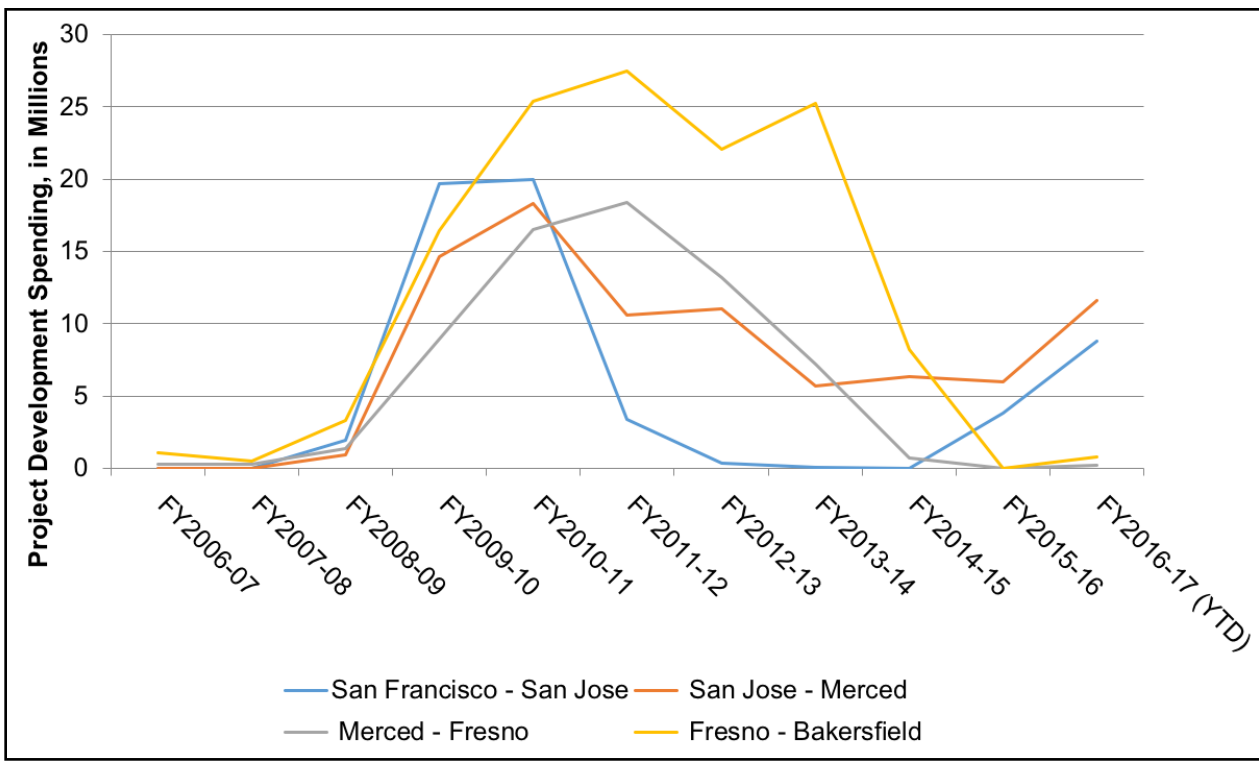


Figure 5. Project Development Spending by Geographic Segment, FY 2006/7 through FY 2016/17

Source: CHSRA, 2017. "Total Project Expenditures with Forecasts, July 2017." Accessed December 12, 2017 from http://www.hsr.ca.gov/docs/brdmeetings/2017/brdmtg_071817_FA_Total_Project_Expenditures_with_Forecasts.pdf

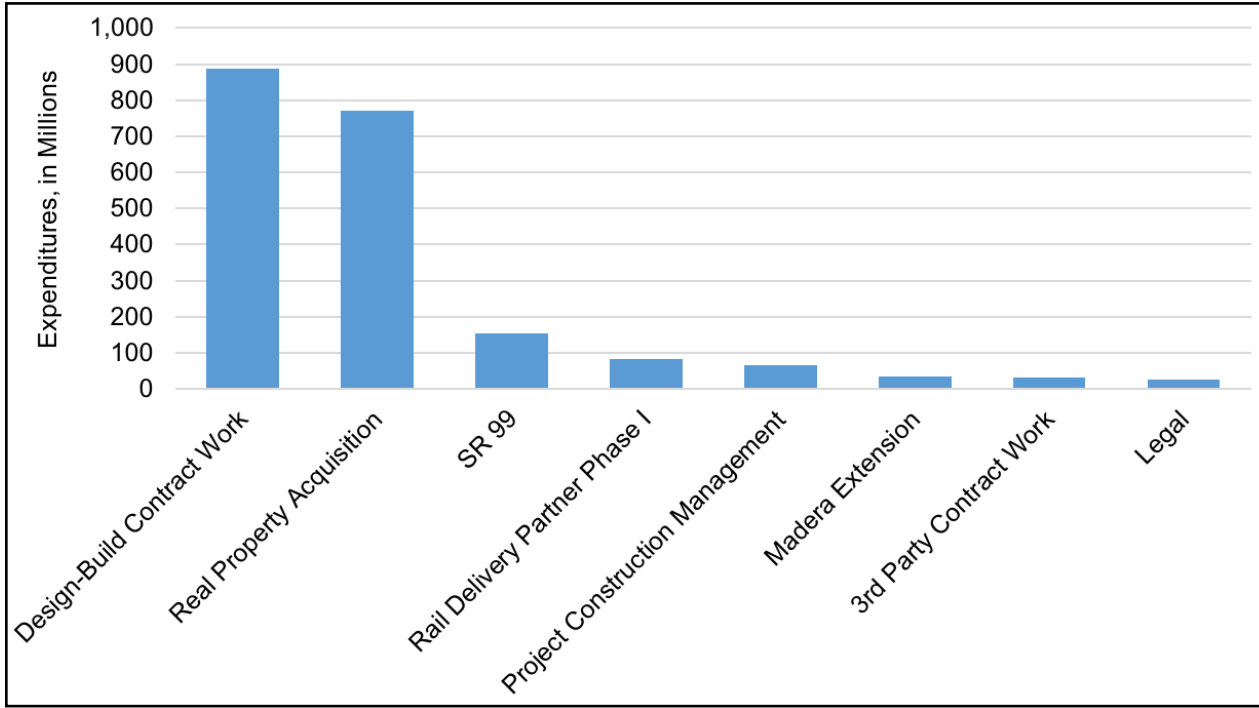


Figure 6. Total Spending by Construction Program, FY 2006/7 through FY 2015/16

Source: CHSRA, 2017. "Total Project Expenditures with Forecasts, July 2017." Accessed December 12, 2017 from http://www.hsr.ca.gov/docs/brdmeetings/2017/brdmtg_071817_FA_Total_Project_Expenditures_with_Forecasts.pdf

While the TPEF report provides a useful overview of spending on the HSR project to date, when considering its usefulness for analyses of economic impact, it suffers from some deficiencies—principally, the aggregate nature of the expenditure amounts. For example, as already noted, it is not possible with the TPEF report to disaggregate design-build construction spending for the various construction packages. Therefore, the analysis in this report uses three other sources of HSR expenditure data.

Funding Contribution Plans and Other Data Sources

In addition to the TPEF report, three other data sources used in this report include:

1. *Funding Contribution Plan* (FCP) reports;
2. *Contracts and Expenditures* (C&E) reports; and
3. Master contracts file provided by CHSRA.

The first two of these data sources are publicly available; the research team was provided special in-house versions of these. The major advantage of having the in-house versions of these first two sources was simply ease of access for data analysis, as well as having identifying information for the various contractors (specifically, contract number). In the economic impact analysis that follows in Chapters IV and V, only publicly available spending data is used.

Funding Contribution Plans

The Funding Contribution Plan (FCP) is the single most important source of input data in this research's EIA. The CHSRA is required by the Federal Railroad Administration (FRA) to file FCP reports as a condition of receiving ARRA funding. These reports list expenditures by task and by segment and, while still aggregate, present the data at a more refined geographical area, including by construction package.²⁶ FCP reports also contain forecasts of spending beyond 2017, unlike the TPEF report.

The FCP report follows FRA guidelines in reporting spending by task. This classification system defines ten broad tasks which are further subdivided into subtasks and sub-subtasks. Table 1 lists the distinct tasks in the FCP, which are far more detailed than in the TPEF report.

Table 1. Funding Contribution Plan Tasks

Task #	Description	Number of subtasks	Breakdown	
			by geography available?	Breakdown by construction package available?
1	Environmental Review	8	Y	N
2	Preliminary Engineering (PE)	3	Y	N
3	Other Related Work Needed Prior to Start of Construction	8	Y	N
4	Project Admin & Statewide Cost Allocation Plan (SWCAP)	1	Y	N
5	Program, Project and FCS Construction Management	3*	N	Y
6	Real Property Acquisition and Environmental Mitigation	4*	N	Y
7	Early Works	1	N	N
8	Final Design and Construction Contract Work for the FCS	5*	N	Y
9	Interim Use Project Reserve	2	N	N
10	Unallocated Contingency	1	N	N

* Tasks 5, 6 and 8 have seven, nine and thirteen sub-subtasks, respectively.

Detailed forecasted spending amounts for each subtask from the FCP and a discussion regarding what costs align with CP1 are available in the report's supplemental materials (Supplemental Materials A, <http://transweb.sjsu.edu/research/1627>).

Other Data Sources

Two other key sources of data used in this report are *Contract and Expenditure* (C&E) reports and a Master Contracts File.

C&E reports are publicly-available, monthly reports that list spending by contract and vendor name for all active CHSRA contracts.²⁷ The versions of these reports accessed by the research team contain contract numbers, which is useful, as some vendors have multiple contracts with CHSRA.

Finally, the Master Contracts file contains data on all active, expired and pending contracts executed by CHSRA. In addition to listing contractor names and numbers, the file contains initial contract amount for most but not all contracts. The "master contracts file" lists all contract start and end dates, as well as a brief description of the type of contract.

Supplemental Materials B provides a detailed description and analysis of the contracts and contractors involved with CP1, while Supplemental Materials C explores how the data from the contracts map to the FCP report. Both are available to download: <http://transweb.sjsu.edu/research/1627>.

SUMMARIZING SPENDING ON CP1

Using the data sources noted above, and described in significantly more detail in Supplemental Materials A through C, this section presents estimates of spending attributable to CP1. Table 2 presents a summary of CP1 spending.

Table 2. Total Spending on CP1

Category	Amount (\$)	Source notes
Design Build	1,283,047,960	FCP; Task 8.2.1
RoW Acquisition	438,543,614	FCP; Task 6.4.1
SR-99	260,900,000	FCP; Task 8.1
Third Parties CP1	188,070,152	FCP; Task 8.2.3
Madera Ext	153,399,844	FCP; Task 8.2.4
RoW Services & Relocation	127,215,529	FCP; Task 6.2.1
Rail Delivery Partner	49,876,147	FCP; 12.8% of Task 5.1.1
Project Construction Management	34,208,889	FCP; Task 5.2.1
Environmental Review	32,824,348	FCP; Task 1, Merced-Fresno section
Preliminary RoW	24,327,386	FCP; Task 6.1
Administrative	20,656,818	TPEF; 12.8% of total admin expenditure
Preliminary Engineering	16,188,140	FCP; Task 2, Merced-Fresno section
RoW Mitigation	15,100,000	FCP; Task 6.3.1
Other Project Development Work	8,150,969	FCP; Task 3, Merced-Fresno section
Network Integration	1,093,719	FCP; 12.8% of Task 5.1.2
Legal	552,540	FCP; 12.8% of Task 5.3.1
Total Spending	2,654,156,054	

The administrative category (associated with \$20,656,818 in spending) was calculated as 12.8% of the total cumulating spending on administrative functions to date and was taken from the TPEF report. The full derivation of this 12.8% figure is discussed in Supplemental Materials B in the section on Nine Major Contracts; in short, it is the fraction of the area of CP1 divided by the total system length.

All other categories and spending amounts are from the FCP report. The first three categories (Environmental Review, Preliminary Engineering and Other Project Development Work) are totals for the Merced-Fresno section only. For planning and engineering purposes, CP1 spans *both* the Merced-Fresno and Fresno-Bakersfield sections. Rather than taking a weighted average of expenditures in these two sections, the research team elected to use the spending for the Merced-Fresno section only; this choice may be interpreted as a simplifying assumption, justified by the fact that planning expenditures are quite small when compared to construction and RoW expenditures. Spending listed in Table 2 for the categories of Rail Delivery Partner, Network Integration, and Legal comprises 12.8% of the totals for these three system-wide tasks. Finally, the construction categories, as well as Project Construction Management, are all associated with CP1.

CP1, as conceptualized in this report, contains planning and managerial spending, in addition to the more visible categories of construction and RoW-related spending. The project does not include all of the spending, however, that will be required to run trains on the track. The total in Table 2 does not include track work, nor does it include spending on station construction as these costs are not part of CP1.

On a project as vast and complex as the HSR project, narrowing down spending to a single physical area, or “construction package,” is a challenge, because certain tasks, due to their timing or nature, extend outside geographical boundaries. Although we included legal categories (FCP subtask 3.8, which is included in the total of task 3, and FCP subtask 5.3), none of the included spending reflects financial services; from the “major contracts” list received from CHSRA and discussed in Supplemental Materials B, part of the KPMG contract could arguably be attributed to CP1. Different analysts might have made different decisions regarding which spending to include and which to exclude, but any analysts would include the obvious categories—physical construction and RoW—that make up the large majority of included spending.

Figure 7 shows CP1 spending by category. Spending on functions classified as Management and Project Development sum to 4% and 2% of the total, respectively, while Construction accounts for 71% and RoW spending accounts for the remaining 23%. As discussed above, some minor spending omissions (such as the KPMG contract, discussed in Supplemental Materials B) are unlikely to dramatically impact the economic modeling.

Figure 8 breaks down the four broad spending categories shown in Figure 7 into more detail.

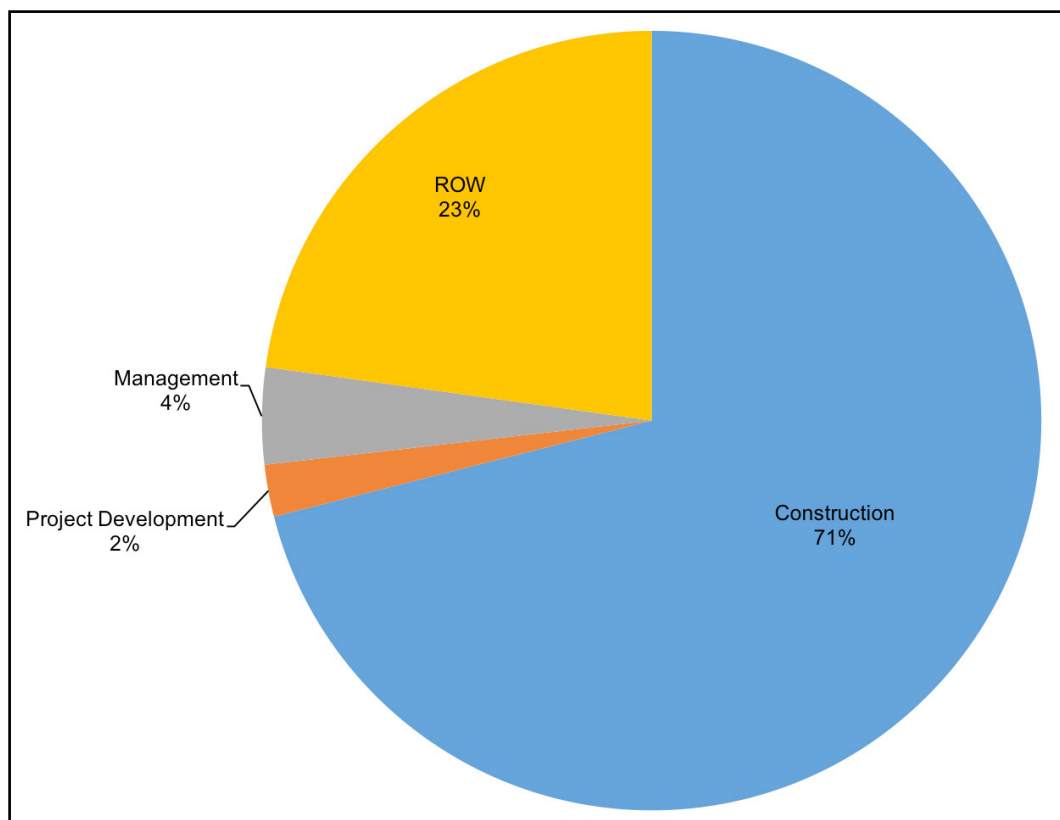


Figure 7. CP1 Spending, by Category

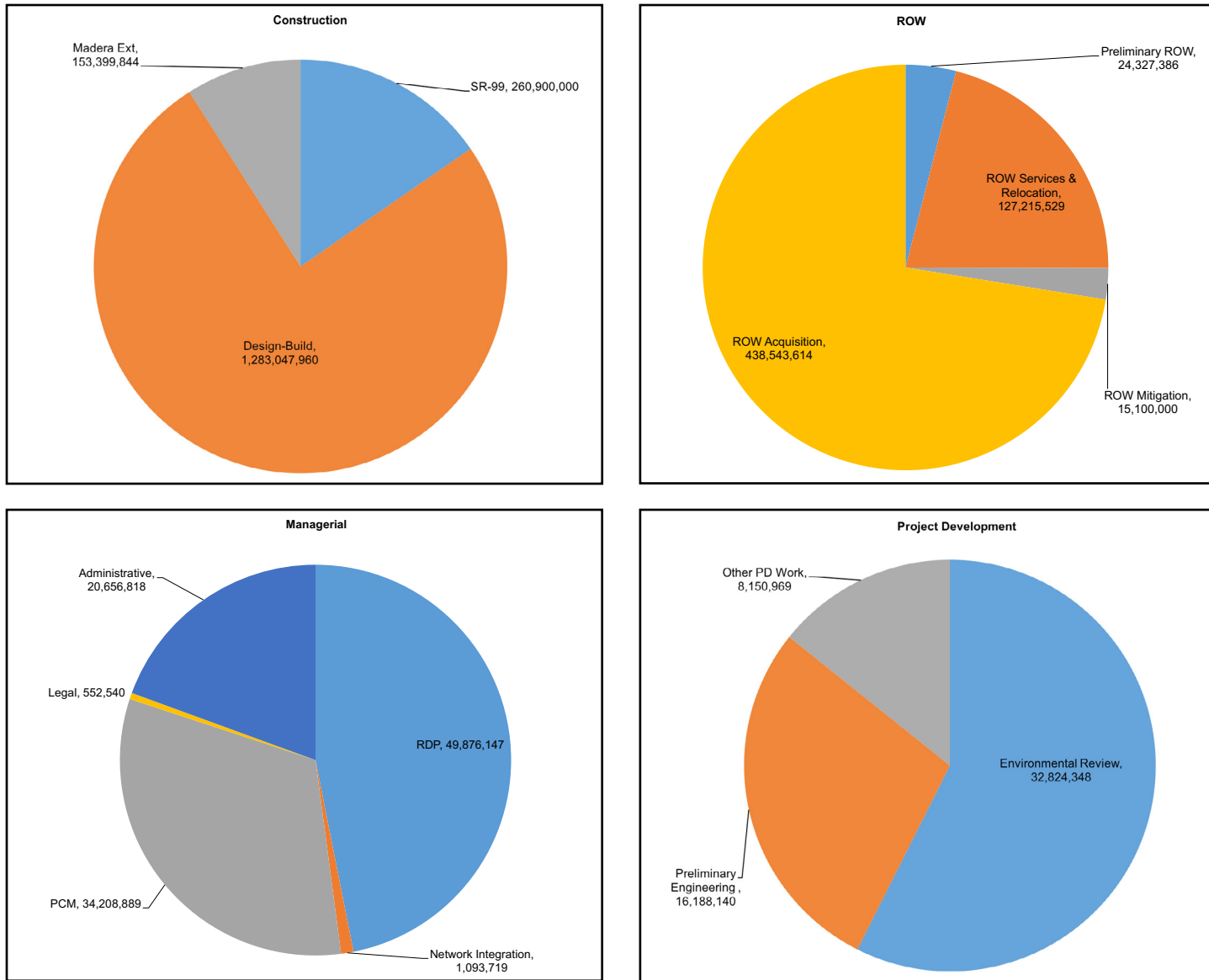


Figure 8. Spending Detail Across CP1 Categories

To determine spending on CP1, this analysis used both a contract-based approach and an aggregate approach. Determining expenditures using a contract-based approach (i.e. identifying all the contracts relevant to CP1 and adding up the spending amounts by category) has some advantages over the aggregate amounts listed in the FCP report. For example, by carefully researching each contract, the research team could determine with more accuracy whether and, if so, what fraction of the contract can be considered to be work-relevant to CP1. However, examining each contract at the level of detail required for this approach, even for a relatively small portion of the project such as CP1, is very time-consuming and potentially error-prone. Therefore, the analytical chapters that follow use the FCP data as primary inputs but will refer to all of the other data sources described above, including those on individual contracts, to determine supplemental information, including, most importantly, the geographic area in which the spending occurred.

To summarize, the total CP1 spending used for the REMI forecast model in this study totals to \$2.654 billion and covers the years 2014 to 2019.

IV. MODELING ECONOMIC IMPACTS OF HSR CONSTRUCTION IN THE CENTRAL VALLEY: ABOUT THE PROCESS

The economic forecasting and policy analysis tool used for this research was developed by Regional Economic Models, Inc. (REMI). The REMI Model enables users to predict impacts on a regional economy under different scenarios. It falls within the same broad category of input-output and general equilibrium models as other tools such as the RIMS II (Regional Input-Output Modeling System) Model, developed by the Bureau of Economic Analysis, and the IMPLAN Model.²⁸

In this chapter, the researchers provide an overview of the REMI Model and describe how the input data from CHSRA were converted into a format suitable for use in the REMI Model. The next chapter describes the results obtained from the REMI Model and the interpretation of that output with a focus on employment forecasts.

OVERVIEW OF THE REMI MODEL

The REMI Model is a dynamic, multi-region economic simulation model that encompasses input-output relationships, calibrated to regional data for user-designated regions. That is, it is specifically designed to allow users to explore the economic impacts of policy actions for specific, user-defined geographic regions. For this project, the researchers designated four regions: Madera County, Fresno County, Merced County, and the Rest-of-California (see Figure 9). The rationale for this selection is straightforward. Madera and Fresno Counties are the sites of the major construction under CP1, whereas Merced County is the largest county (by population and economic activity) adjacent to either Madera or Fresno Counties. Therefore, indirect and induced employment effects due to CP1 activities in the Central Valley outside of Madera or Fresno Counties are most likely to be reflected in Merced County.²⁹ Figure 9 shows the regions considered in our REMI Model.

Furthermore, a significant part of CP1 spending, while directed to activities in Madera and Fresno Counties, occurs in other parts of California. In developing the model below, we will show how we account for this fact (our “HSR Base Case”) and the consequences of not accounting for this fact (the “Raw FCP Base Case”). Economic effects of CP1 spending in California outside of Madera, Fresno, or Merced Counties will be captured in the Rest-of-California region. Both these cases are contrasted with the “REMI Base Case,” which assumes no additional HSR spending after 2014. We also consider several alternative spending scenarios.



Figure 9. Study Regions/Counties for the REMI Model

A regional input-output model accounts for inter-industry and inter-regional linkages in the production process and the effects of spending on income, employment, and other economic variables such as prices. For example, an increase in spending on construction materials and equipment will cause an increase in demand for the inputs used to produce construction materials and equipment (i.e., indirect effects). Furthermore, an increased demand for construction materials and equipment will result in greater use of labor in specific industries and occupations, resulting in higher incomes and higher spending by workers (i.e., induced effects). An initial increase in spending on construction materials and equipment begets increased income, which begets increased spending, and so on. Thus, an initial increase in spending will have a magnified or *multiplier* effect on future income and spending. (The concept of employment multipliers is widely used in regional economics,³⁰ input-output analysis,³¹ and economic impact analysis.³²) If the initial spending can be identified with a specific industry and a specific location, the resultant spending can be tied, to some extent, to specific industries, occupations, and locations. In the next chapter, we explore these impacts specifically in connection with CP1 spending.

The timing of spending is important in determining its impact. The same dollar amount of spending over, say, a five-year period has different effects depending on whether the bulk of spending occurs early in the period or later in the period. Furthermore, the spending in one year has effects that may last several years because additional hiring and additional income generation takes time to occur. These timing or “dynamic” effects are accounted for in the REMI Model. The researchers used both actual and forecasted spending over the course of CP1 as inputs to the model and present forecasts of effects of this spending both during the course of CP1 and for a decade after CP1 spending ends.

The REMI Model also accounts for dynamic interactions among industries and regions. Thus, additional spending in a given region affects the size and composition of firms in the region (via investment) and the size and composition of the workforce (via migration) in the region in the future. The effects of this changing industry structure are captured in the “Dynamic Trade Shares” measure generated by the REMI Model. The Dynamic Trade Shares are the fractions of spending directed *to* a region that are spent *in* that region and in other regions. In our REMI input, for example, spending for construction directed to Fresno County occurs partly in Fresno County, partly in Madera and Merced Counties, partly in the Rest-of-California, partly in the Rest-of-the-Nation (US), and partly in the Rest-of-the-World. These Dynamic Trade Shares differ by region and also by year (in response to prior years’ spending) for the reasons mentioned above. The REMI Dynamic Trade Shares employed in the analysis are detailed in Supplemental Materials D, available online at <http://transweb.sjsu.edu/research/1627>.

Furthermore, spending affects local prices, therefore affecting the relative attractiveness of one region compared to another. As prices, such as housing prices, adjust because of policy-induced spending, the relative attractiveness of regions for households changes. The REMI Model accounts for these price effects and for the feedback that such price effects may have on labor supply.

Structure of the REMI Model³³

The REMI Model has a modular structure as shown in Figure 10 and Figure 11.

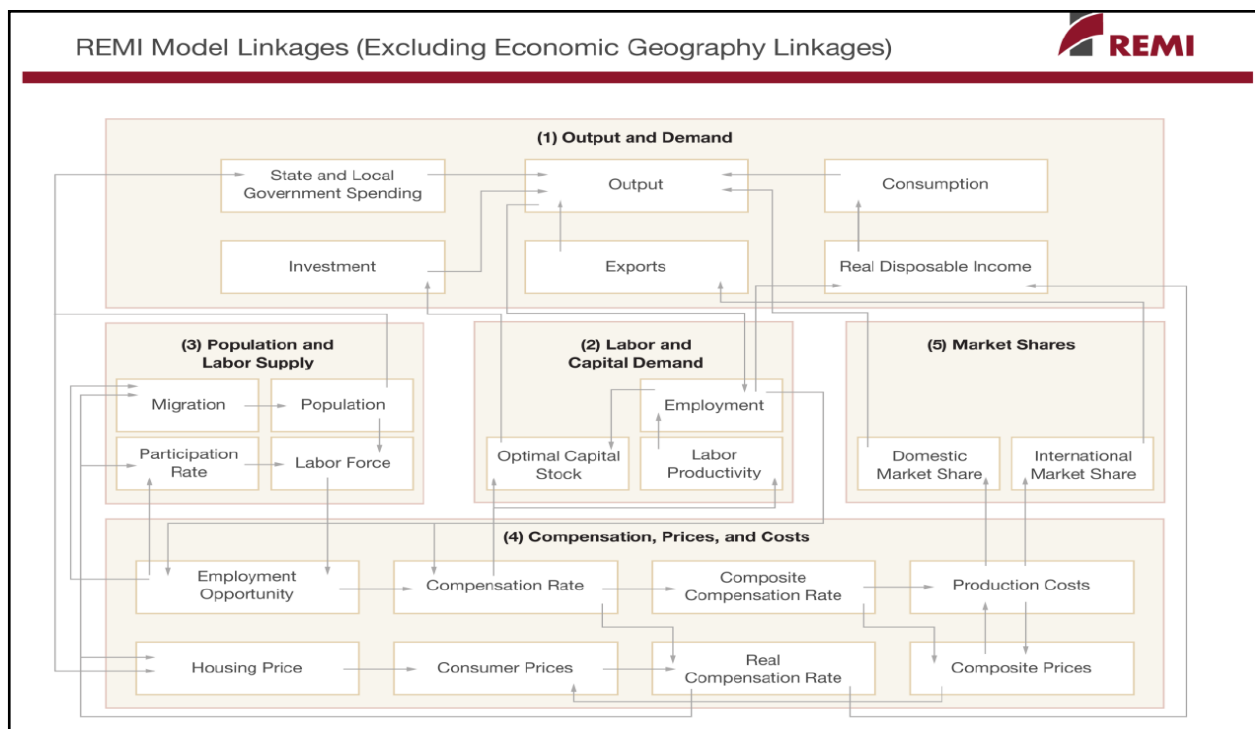


Figure 10. Main Components of the REMI Model

Source: REMI PI+ ver. 2.1 Model Equations.

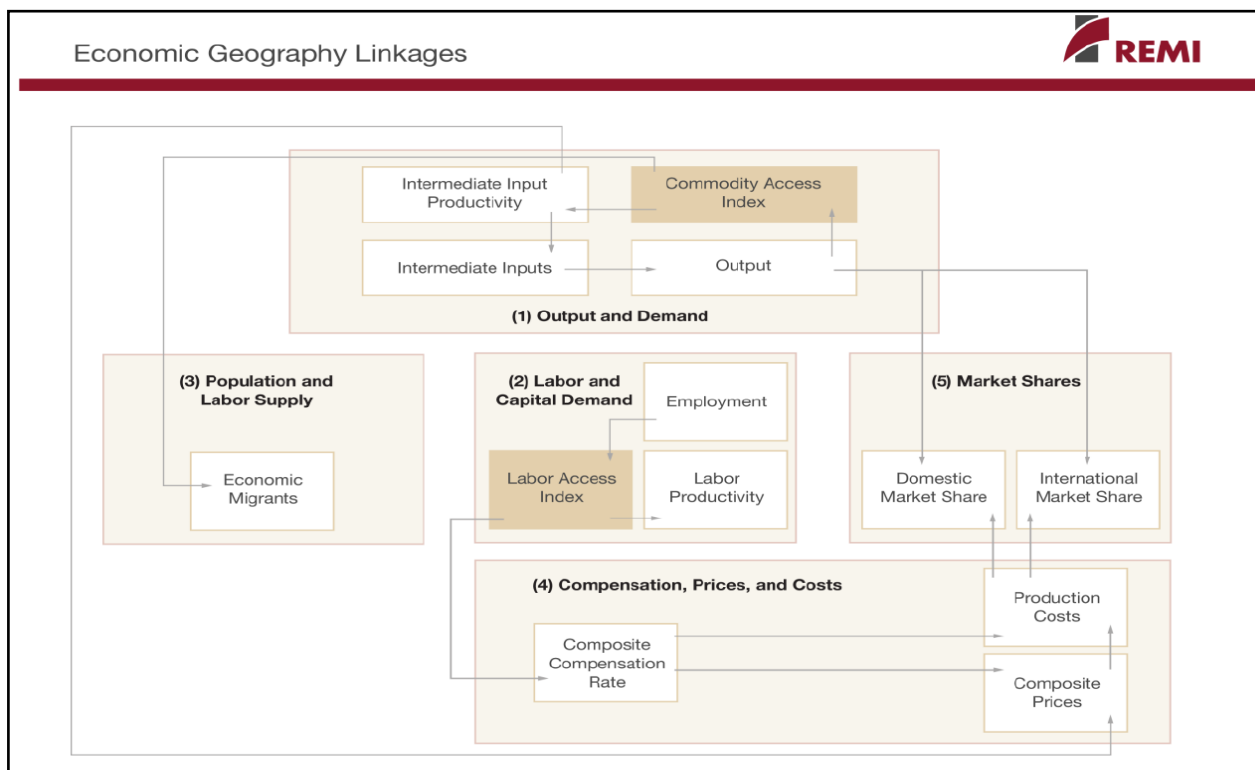


Figure 11. Economic Geography Linkages of the REMI Model

Source: REMI PI+ ver. 2.1 Model Equations.

As Figure 10 shows, there are five main components in the REMI Model:

1. Output and demand (Block 1);
2. Labor and capital demand (Block 2);
3. Population and labor supply (Block 3);
4. Compensation, prices, and costs (Block 4); and
5. Market shares (Block 5).

Figure 11 highlights the economic geography components of the REMI Model—namely, the regional feedback mechanisms built into the Model. Such mechanisms account for, among other things, increased migration of workers brought on by increased job opportunities. For example, some construction workers from other regions migrate to Madera or Fresno Counties because of CP1-related spending.

Inputs to the REMI Model

The basic inputs to the REMI Model are changes in spending levels against a baseline of spending projected over time, within particular industries, and occurring in specific regions. To create the dataset required to apply the REMI Model, the researchers developed a temporal profile of CP1 spending by industry and by region. This was done by making several assumptions about spending on various tasks identified in the Funding Contribution Plan (FCP) reports (hereafter, the FCP Dataset), which is the data source that most effectively allows for the identification of the timing, industry, and region of a prospective expenditure.

The REMI Model is calibrated to a particular year, and the model can be run with no policy changes. The resultant output represents the estimated effects of the REMI Base Case. If policy changes (such as spending on HSR) are introduced, the effects are measured relative to the REMI Base Case.

The REMI Model used in this analysis is calibrated to 2014. This means that policy actions taken up to and including 2014 are already incorporated into the model, and *policy changes* consist of additional spending occurring or planned after 2014.

In formulating the inputs for the REMI Model, we consider a variety of alternatives. The REMI Base Case and our policy alternatives are indicated in Table 3.

Table 3. Description of Alternative Scenarios Considered in the REMI Analysis

Scenario Name	Type of Expenditure Values	Description
REMI Base Case	N/A	Base case against which other alternatives are compared. Calibrated to 2014 and assumes no policy changes (e.g. HSR spending) after this date.
HSR Base Case	Nominal	Spending reflected in FCP data, adjusted by Dynamic Trade Shares.
Raw FCP Case	Nominal	Spending reflected in FCP data, unadjusted.
HSR Base Case Real 1%	Real	Real base case spending, assuming 1% inflation in 2018-2019.
HSR Base Case Real 2.5%	Real	Real base case spending, assuming 2.5% inflation in 2018-2019.
Expenditure-equivalent transfer payments	Nominal	Identical expenditures to the HSR Base Case all assumed to be transfer payments.

The first row in Table 3 is the REMI Base Case. This is the built-in scenario of spending assuming no changes in policy from the 2014 levels of spending. The remaining rows of the table are various alternatives to the REMI Base Case.

Policy changes from the REMI Base Case, such as spending on HSR, can be represented as changes to some of these components from a given base level. The REMI Model traces the effects of such changes following the connections among the components illustrated in Figure 10. Spending under CP1 is modeled as increases in spending in the first module (Block 1, Output and Demand). This change is traced through all other blocks. The researchers focus on the implications for variables in Block 2 (Labor and Capital Demand), specifically on employment.

Our main alternative is called the *HSR Base Case*. The HSR Base Case is a policy change from the REMI Base Case. The HSR Base Case represents our best assumption regarding the course of spending based on data about actual and expected spending on CP1. We detail the development of inputs for the HSR Base Case below. The remaining rows of the table indicate various alternatives to this best guess about actual and expected spending on CP1, as explained below. These alternatives represent other reasonable assumptions or alternatives to using funds for HSR.

DATA MANIPULATION

To understand the HSR Base Case, it is necessary to describe how the data from the CHSRA were converted for use in the REMI Model. The FCP Dataset (described above and in Chapter III) provides the main inputs for the REMI Model. The raw FCP data are converted into inputs suitable for the REMI Model through a multi-stage process as illustrated in Figure 12. The original FCP data (STEP 0) is in terms of California Fiscal Years (FY), i.e. July 1 to June 30, and monthly actual and projected spending; the spending amounts in the FCP data are nominal (“year of expenditure”) dollars, not adjusted for inflation. The REMI Model uses Calendar Year (CY) data. The original FCP data are available annually by fiscal year from 2014–2015 to 2015–2016 and monthly from 2016 to 2019, when CP1 spending ends. The data represent actual expenditures through March 2017

and forecast expenditures thereafter. As noted above, the REMI Model is calibrated to 2014, so spending before this period is already accounted for in the model and built into the REMI Base Case.

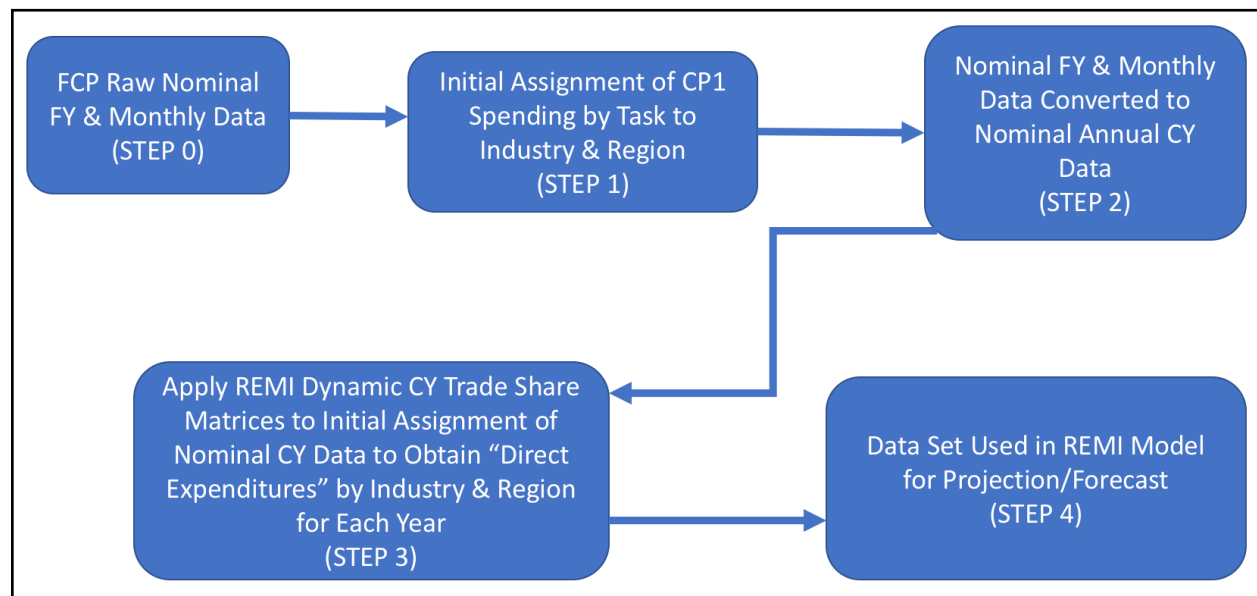


Figure 12. Flowchart of Data Manipulation for the REMI Model

The researchers made an initial assignment of fiscal year spending by task to CP1 (vs. non-CP1) and identified the industry and the region which is the object of the spending, as indicated in Supplemental Materials E (STEP 1) available online at <http://transweb.sjsu.edu/research/1627>. This initial assignment was based on the task description (which is sometimes specific as to industry and region), or on the proportion of previous similar spending by region.

The spending was then converted to calendar year spending (STEP 2) as required by the REMI Model. When there were no monthly data on spending, the researchers divided the fiscal year spending equally and assigned equal amounts to each calendar year. When monthly detail was provided, the researchers aggregated the monthly spending by calendar year.

Because spending directed to a region is not necessarily spent in the region, the researchers applied the REMI Dynamic Trade Shares to identify the regions where direct spending would occur (STEP 3). These regions include the four regions designated in our REMI Model (Fresno, Madera, Merced, and Rest-of-California) plus two other regions: the Rest-of-the-Nation (RoN) and the Rest-of-the-World.

The REMI Dynamic Trade Shares for a given industry are represented by a matrix that gives the percentage of direct expenditures in each region for given spending directed to a particular region. The dynamic trade shares are specific to each industry, and, for a given industry, they can change over time, because spending will alter investment in the industry.

The authors used the Dynamic Trade Shares to go from the raw spending directed to a region to spending which occurs in a region by multiplying the level of spending by the fraction of spending that will occur in a region for that category of spending. For example, if there is substantial design work directed to Madera County, it is likely that some fraction of that design spending will occur in Madera County, but also that a large portion of the design spending will occur outside of Madera County (which does not have a strong engineering and design employment base). The fractions of spending that will occur in a particular location are generated by the REMI Model as part of the Dynamic Trade Shares.

For example, the matrix labeled Ind A in Table 4 below (and also shown in Supplemental Materials F, <http://transweb.sjsu.edu/research/1627>), shows, for spending directed to Region I, that the fraction of spending which directly occurs in Region I is a_{11} , while the fraction of spending directed to Region I which directly occurs in Region II is a_{21} , the fraction that directly occurs in Region III is a_{31} , the fraction that directly occurs in Region IV is a_{41} , the fraction that directly occurs in the Rest-of-the-Nation (RoN) is a_{51} , and the fraction that occurs in the Rest-of-the-World is a_{61} . The sum of $a_{11}+a_{21}+a_{31}+a_{41}+a_{51}+a_{61}$ equals 100%.

Table 4. REMI Calendar Year Dynamic Trade Share Matrices

Ind A	Reg I	Reg II	Reg III	Reg IV
Reg I	a_{11}	a_{12}	a_{13}	a_{14}
Reg II	a_{21}	a_{22}	a_{23}	a_{24}
Reg III	a_{31}	a_{32}	a_{33}	a_{34}
Reg IV	a_{41}	a_{42}	a_{43}	a_{44}
RoN	a_{51}	a_{52}	a_{53}	a_{54}
RoW	a_{61}	a_{62}	a_{63}	a_{64}

The scheme for converting the initial CY FCP data to adjusted direct expenditures by industry and region is described in Supplemental Materials F (for a hypothetical example with three industries (A, B, and C) and four regions (I, II, III, and IV)) and is available to download from <http://transweb.sjsu.edu/research/1627>. The actual Annual REMI Dynamic Trade Share Matrices used in converting the FCP dataset are given in Supplemental Materials D. Supplemental Materials D gives the actual Dynamic Trade Share Matrices that the researchers used to adjust the STEP 2 data. These Dynamic Trade Shares are generated by the REMI Model based on the spending pattern of CP1. The resultant data set (STEP 4) is used as the input for the REMI Model in the HSR Base Case.

Supplemental Materials G compares the initial (STEP 2) data with the final (STEP 4) adjusted data. The sum of spending for each year is the same in the initial and the adjusted data. The Total amounts in Supplemental Materials G do not include the RoN and Rest-of-the-World spending, so the adjusted totals are always less than the original totals. Additionally, Supplemental Materials F provides the proportions of total in-California spending by industry and region. All supplemental materials can be downloaded from <http://transweb.sjsu.edu/research/1627>.

The HSR Base Case Input to the REMI Model

Temporal Profile of CP1 Spending

The temporal profile of CP1 actual and forecast spending is shown in Figure 13. The REMI Model used in this analysis is calibrated to 2014 data. Therefore, we measure the impact of additional spending starting in 2015. Our data about spending includes actual spending for 2015, 2016, and the first quarter of 2017. Thereafter, we use forecasted spending. CP1 spending ends in 2019.

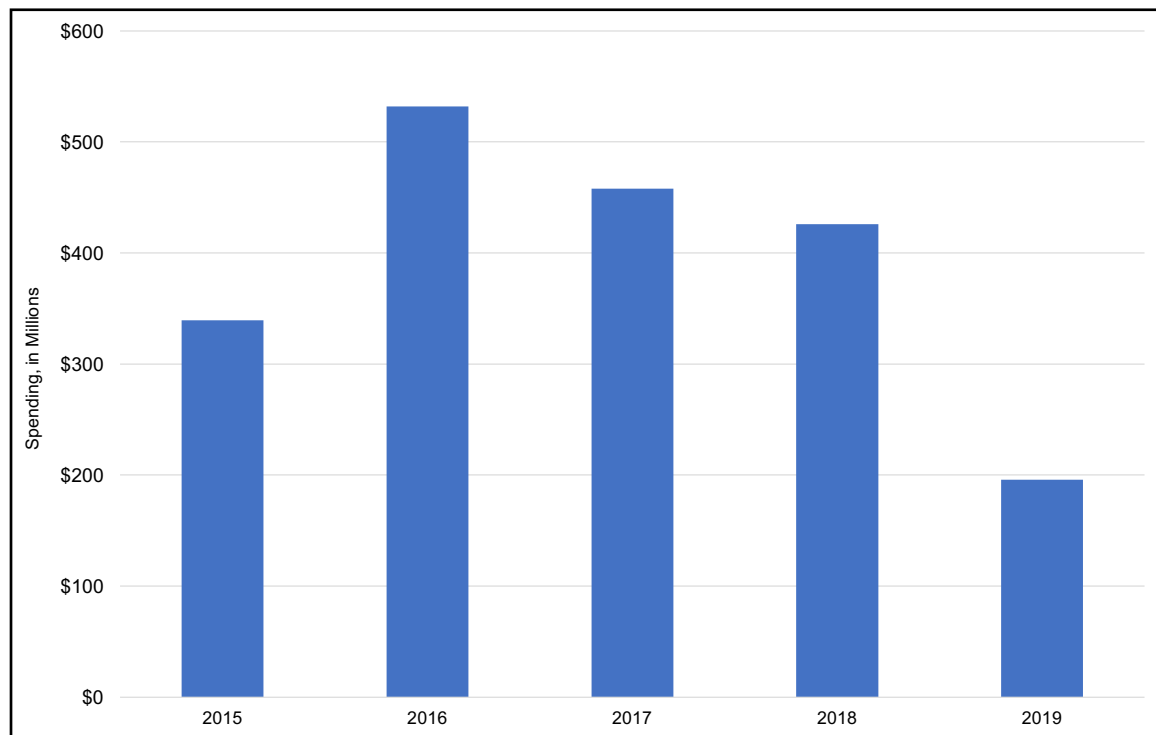


Figure 13. Temporal Profile of CP1 Actual and Forecast Spending

Industry Profile of CP1 Spending

The researchers categorized CP1 spending into seven industries or categories. They are:

1. Construction: Highways and streets

The category “Highways and streets” was selected as the best fit from a list of construction activities including: single-family residential structures, multifamily residential structures, manufacturing structures, etc.

2. Real estate: Other real estate

Other real estate was selected as the best fit from a list that included “Housing.” The real estate category includes only spending on real estate services, not right-of-way acquisition payments. Right-of-way acquisition payments are treated as

transfer payments; this differs from the WSP analysis discussed in Chapter II, which included RoW services but not acquisition payments.

3. Legal services
4. Architectural, engineering, and related services
5. Management consulting services
6. Environmental and other technical consulting services
7. Transfer payments

Transfer payments are defined as “payments to persons for which no current services are performed.” The category includes Social Security payments, Earned Income Tax Credit, etc. We treat right-of-way acquisition payments as “Other transfer receipts of individuals from governments.”

Although total spending varies over the input horizon, spending is heavily concentrated in “Construction: Highways and streets” and “Transfer payments” (see Figure 14).

Regional Profile of CP1 Spending

The heaviest concentration of CP1 spending in each input year is in Fresno and Madera Counties (see Figure 15).

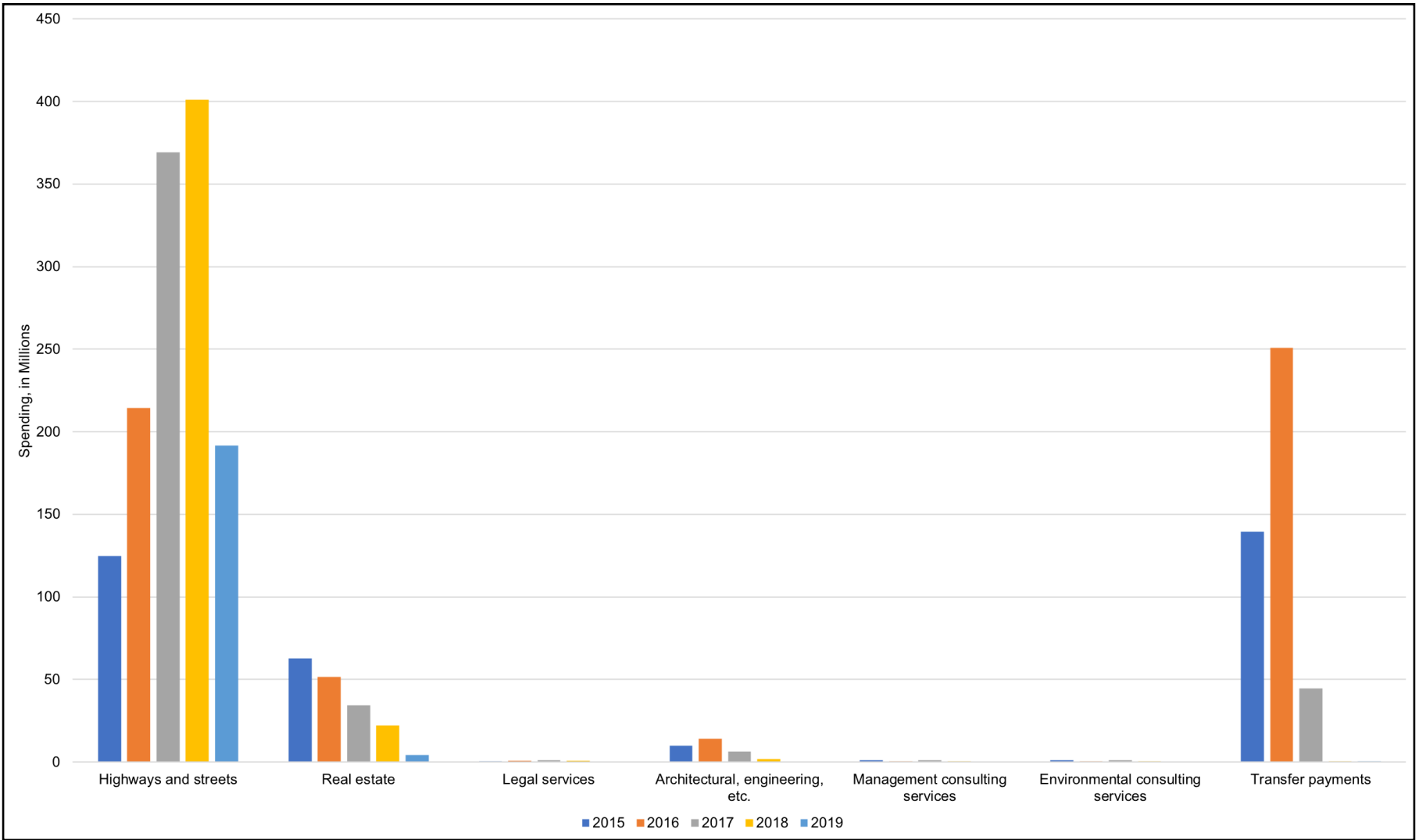


Figure 14. Spending by Industry/Category, by Year

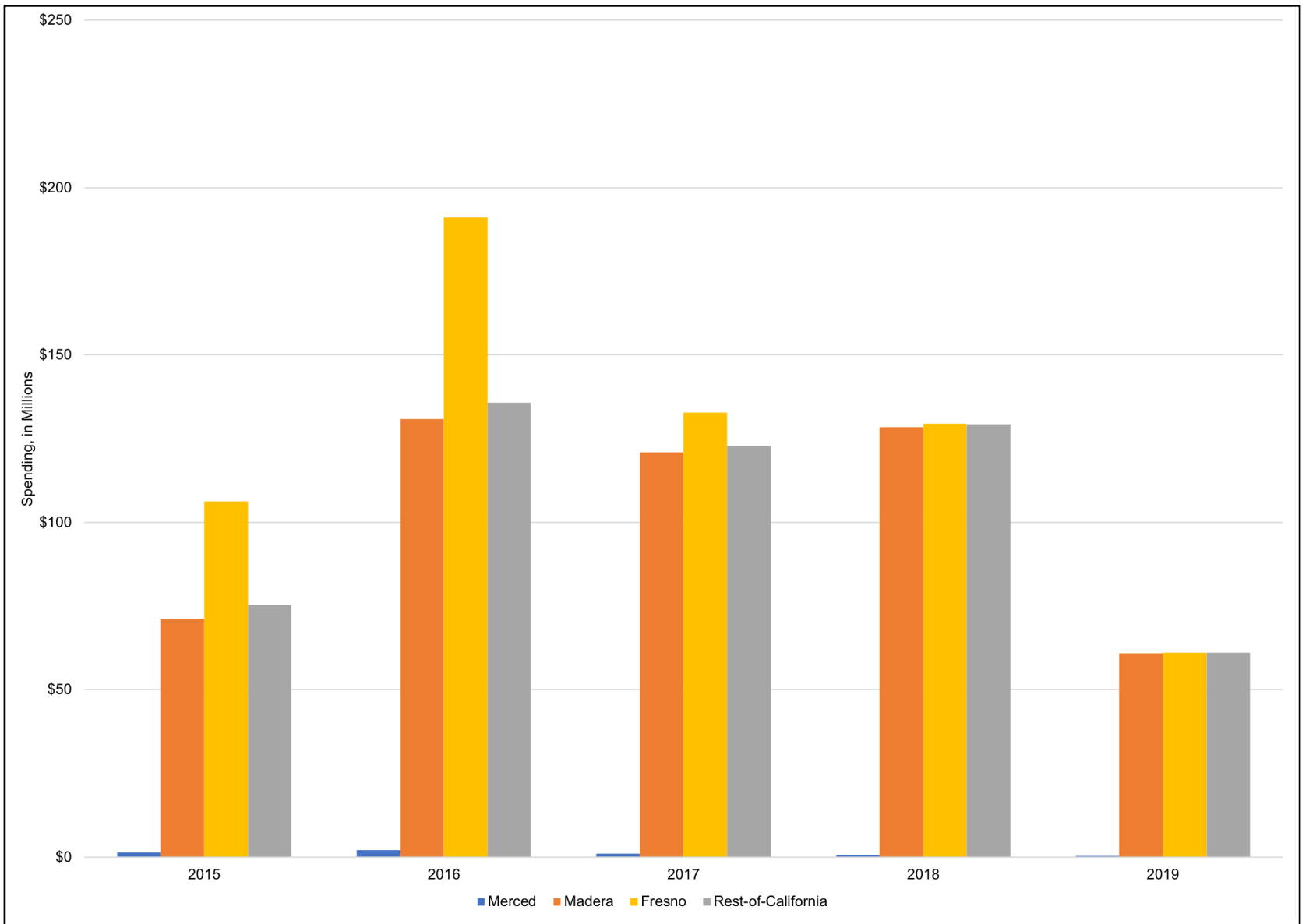


Figure 15. Adjusted Spending by Region, by Year

Alternative Scenarios to the HSR Base Case

Although the HSR Base Case represents our best assumption regarding the appropriate impacts of CP1 spending, it incorporates two critical assumptions about the nature of the inputs. Firstly, our HSR Base Case assumes that spending directed *to* a region is different from spending *within* the region, and we use Dynamic Trade Shares to adjust the spending. If this adjustment had not been made, the Raw FCP (Stage 2) data would have been used as an input to the REMI Model. The alternative scenario, titled “Raw FCP data,” is just that: the FCP data without adjustment using Dynamic Trade Shares. (Table 3 lists the alternative scenarios considered.)

Secondly, the FCP data are in *nominal* terms. That is, these data do not account for the effects of inflation as inputted. Data in *real* terms would control for the effects of inflation. The REMI Model allows one to enter either nominal or real data. If nominal data is entered, the REMI Model converts the data to real data based on estimates *built into* the REMI Base Case about the course of future inflation. If real data are entered, the *researchers decide* how to represent the future course of inflation. In the HSR Base Case, the authors used nominal data and allowed the REMI Model to make the conversion. In two of the alternative cases, it was the researchers who made the conversion using alternative assumptions about the future course of inflation. The course of future inflation is unknown—as of this writing—for three quarters of 2018 and 2019. The researchers consider two possibilities: low inflation (1% per year) or high inflation (2.5% per year). The researchers took the HSR Base Case nominal data and converted them into real terms under each of the alternative inflation assumptions mentioned. These are the scenarios, labeled “HSR Base Case Real 1%” and “HSR Base Case Real 2.5%,” respectively.

Third, the researchers considered what would happen if, instead of spending funds on CP1, an equivalent amount of money had been distributed (e.g. as tax cuts) in the same way geographically as the funds in our HSR Base Case. This is the last scenario: “Expenditure-equivalent transfer payments.”

In summary, our alternatives to the REMI Base Case are:

- HSR Base Case: Estimates based on FCP data (STEP 4) with nominal data adjusted to real within the REMI Model and the location of spending adjusted using Dynamic Trade Shares generated by the REMI Model;
- Raw FCP data: Estimates based on the raw FCP (STEP 2) data, with no adjustment for the location of spending using dynamic trade shares;
- HSR Base Case Real 1% and 2.5%: Estimates based on using real as opposed to nominal spending amounts. The current version of the REMI Model can accommodate either nominal or real spending. Original data are invariably in nominal terms. When forecast values of future spending are used, the adjustment to real values must be based on expected future inflation rates. If nominal values are used as inputs, the REMI Model adjusts those values based on the Model’s expectation of future inflation. If the user makes the conversion to real values, then the user must

specify expectations about future inflation. The researchers converted our data to real values under two different assumptions about future inflation in the period 2018-2019: inflation of 1% and 2.5% per year. The researchers show a comparison between when the employment implications of the model simulations when nominal values are used and the alternative assumptions about future inflation when real values are used. Broadly speaking, the estimates are similar.

- Expenditure-equivalent transfer payments: Estimates based on having spending-equivalent payments treated entirely as transfer payments; this allows for a comparison of the employment effects of CP1 spending with equivalent spending that is entirely consumer driven.

Data for the alternative cases listed in Table 4 are contained in Supplemental Materials H (<http://transweb.sjsu.edu/research/1627>). Supplemental Materials H gives all the alternative data sets employed in the REMI Model. In particular, it shows the nominal and real data (under alternative assumptions about inflation), the raw FCP and adjusted FCP datasets, and the expenditure-equivalent transfer payments dataset.

V. MODELING ECONOMIC IMPACTS OF HSR CONSTRUCTION IN THE CENTRAL VALLEY: RESULTS

In this chapter, employment and related estimates are presented for the policy scenarios outlined in the previous chapter.

TEMPORAL HORIZON

CP1 spending ends in 2019; the employment forecasts contained herein cover the period 2015–2019 (when CP1 spending ends) and a ten-year period following the last projected spending associated with CP1. We examine up until a decade after spending ends, because spending is theorized as having a “ripple effect” on employment. Spending on one category of goods or services at one time begets spending on other goods and services over the course of time. The employment impacts occur through time in this dynamic process. As with a stone thrown into a pond, the ripples or waves caused by the impact (i.e. direct spending) become successively weaker the farther from the point of impact they are. So too with the employment impacts of HSR spending. By considering a ten-year period following the end of CP1 spending, we are confident that we have captured the major impacts of CP1 spending.³⁴

AGGREGATE EMPLOYMENT FORECASTS

In this section, the authors examine in detail the output of the REMI Model in the HSR Base Case, then examining aggregate job-years estimates for all the policy scenarios mentioned in the previous chapter.

The REMI Model suggests that CP1 spending leads to several years of job growth averaging about 5,000 jobs (both part-time and full-time) annually, with a peak of 8,000 jobs. In terms of full-time equivalent job-years, under a fairly conservative scenario, more than 25,000 job-years are created over a 15-year period at a cost of \$67,200 per job-year. However, the complete story is more complex. Depending on the assumptions considered in the modeling, full-time equivalent job forecasts are as high as 30,000. Only in the case of modeling transfer payments directly to consumers at the equivalent expenditure level to the HSR investment does the job forecast fall to approximately 20,000 full-time equivalent job-years. In the rest of this chapter, the researchers present both the raw employment forecasts from the REMI Model and the modeling estimates for the full-time equivalent job-years under several alternative scenarios.

Table 5. Raw REMI Model Employment Forecasts for HSR Base Case Scenario (Number of Additional Jobs^a Relative to the REMI Base Case), by Year for Each Region

Region	Year															Total
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	
All Regions	5,022	8,539	8,260	7,654	3,820	421	-185	-469	-535	-477	-354	-214	-81	29	112	31,542
Merced	32	57	53	50	28	7	1	-2	-3	-3	-3	-2	-1	0	1	215
Madera	613	1,132	1,350	1,435	692	36	-27	-56	-63	-59	-50	-39	-27	-18	-10	4,909
Fresno	2,150	3,649	4,082	3,903	1,996	268	16	-107	-147	-139	-105	-62	-19	18	47	15,550
Rest-of-California	2,227	3,701	2,775	2,266	1,104	110	-175	-304	-322	-276	-196	-111	-34	29	74	10,868

^a Number of additional jobs represents both part-time and full-time employment.

Table 5 provides the raw REMI Model employment forecasts for the HSR Base Case scenario. Overall, the REMI model estimates that the impact of CP1 spending in the HSR Base Case scenario compared to the REMI Base Case will involve the addition of more than 31,500 jobs (both full-time and part-time). At its high point, more than 8,500 jobs are created (in 2016). The estimates include forecast employment for 2015 and 2016 based on actual spending and 2017–2019 forecast employment based on expected spending.

The forecasts extend from 2015—the first year in which policy changes represented by HSR spending are not already reflected in the REMI Model—to 2029, a decade after CP1 expenditures end. Although CP1 spending ends in 2019 induced and indirect effects can be expected to last for some time beyond the end of direct spending. The first row gives the employment forecasts for the aggregate of all regions, and the next three rows give the estimates for each region in our REMI Model (Merced, Madera, Fresno, and Rest-of-California). These raw employment forecasts are all *relative to* the REMI Base Case. They represent additional jobs in each region in each year if the projected spending under HSR takes place compared with what employment would have been without the additional HSR spending.

The raw REMI Model employment forecasts in Table 5 include a mix of part-time and full-time employment. Below, adjustments are made to convert these employment numbers to job-years by accounting for the mix of full-time and part-time employment.

As seen in Table 5, in some years, the employment estimates are negative (but small in magnitude). This effect is due to the REMI Model's inclusion of regional price adjustments. For example, the initial increase in employment in Fresno County will attract workers to Fresno County. These additional workers in Fresno County will cause increased demand for goods and services, whose prices can be expected to rise as a result. This change, in turn, makes Fresno County *less* attractive to some workers, who may migrate to other parts of California or out-of-state. The negative numbers in Table 5 reflect this effect relative to the REMI Base Case of no spending change.

As noted, these raw estimates must be converted to full-time equivalent employment to determine the employment impact in job-years. This adjustment can be made on an industry-by-industry basis, using a table based on Department of Labor data provided by REMI. Using the scenarios from Table 3, the researchers ran employment estimates for each alternative. These raw employment estimates were then adjusted to determine full-time equivalent employment. Full-time equivalent employment adjustment differs by industries, but in the main industries in which we expect employment impacts, the adjustment factors fall into a rather narrow band. In Table 6, aggregate job-years estimates are presented based on two adjustment factors at opposite ends of the band.

Table 6 gives full-time equivalent employment (job-years) aggregates for the scenarios we have outlined. We also present estimates of the cost per job-year and the job-years per billion dollars of real spending for each scenario. Each estimate is presented for two FTE equivalent factors, 0.8 and 0.83, as mentioned above. The real dollars of spending in California differ across the scenarios. The Raw FCP Base Case assumes that spending occurs where it is directed. Because all spending under CP1 is directed to California,

the Raw FCP Base Case assumes, in effect, that all spending occurs in California. So, real expenditure in the Raw FCP Base Case is the largest of all cases detailed in Table 6 (\$2,229,042,985).³⁵ Also, because spending in California is the largest among the alternatives under the Raw FCP scenario, the employment impacts are the largest (in the range 29,214.4 to 30,309.9 job-years). It should be noted, however, that the assumption that all spending associated with CP1 occurs in California is unrealistic. Furthermore, the job-years created under the Raw FCP Base Case assumption are more “expensive” than under other scenarios, in the sense that the cost per job-year is higher (in the range of \$73,541.65 to \$76,299.46 per job-year) compared to some other alternatives, such as the HSR Base Case or either of the HSR Real Base Case alternatives. The last two columns of Table 6 are the reciprocals of the previous two columns, expressed in job-years per billions of dollars of real spending.

Table 6. Overall Full-time Equivalent Employment Estimates for Alternative Scenarios

Scenario Name	Type of Expenditure Values	Description	Aggregate Additional Job-Years Estimate ^a		Real Additional Spending in California ^b	Real Expenditure (Cost) per Job-Year		Jobs per Billion of Real Dollars of Expenditure	
			FTE Adj Factor 0.80	FTE Adj Factor 0.83		FTE Adj Factor 0.80	FTE Adj Factor 0.83	FTE Adj Factor 0.80	FTE Adj Factor 0.83
REMI Base Case	N/A	Base case against which other alternatives are compared	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HSR Base Case	Nominal	Spending reflected in FCP data adjusted by Dynamic Trade Shares	25,231.2	26,177.4	\$1,726,065,591	\$68,409.97	\$65,937.32	14,617.75	15,165.92
Raw FCP Case	Nominal	Spending reflected in FCP data unadjusted	29,214.4	30,309.9	\$2,229,042,985	\$76,299.46	\$73,541.65	13,106.25	13,597.74
HSR Base Case Real 1%	Real	Real base case spending assuming 1% inflation in 2018–2019	27,178.4	28,197.6	\$1,738,316,599	\$63,959.49	\$61,647.70	15,634.90	16,221.21
HSR Base Case Real 2.5%	Real	Real base case spending assuming 2.5% inflation in 2018–2019	26,776.8	27,780.9	\$1,714,087,721	\$64,013.91	\$61,700.16	15,621.60	16,207.41
Expenditure-equivalent Transfer Payments	Nominal	Identical expenditures to Base Case all assumed to be transfer payments	19,891.2	20,637.1	\$1,726,065,591	\$86,775.34	\$83,638.88	11,524.01	11,956.16

Notes:

^a Compared to REMI Base Case.

^b Assuming a 1.75% inflation rate over 2015–2019 unless otherwise specified.

The HSR Base Case is the most conservative in terms of employment effects of HSR spending. For the HSR Base Case, over the 15-year period covered, over 25,000 job-years are created—roughly 14,900 jobs per billion (real) dollars of spending. The corresponding (real) dollars-per-job-year figure is approximately \$67,200.

The employment effects are concentrated in Fresno and the Rest-of-California regions (where the employment effects are of about equal magnitudes) with smaller employment effects in Madera County and small effects in Merced County.

The detailed employment effects by Industry and by Occupation are available to download online in Supplemental Materials I and Supplemental Materials J, respectively, at <http://transweb.sjsu.edu/research/1627>. The cells of these supplemental materials are color-coded, with red indicating the largest relative employment effects and blue indicating the lowest relative employment effects (as in a classic “heat map”).

Broadly speaking, the results show that employment gains in each of the regions will be concentrated by industry in:

- Intermediate Demand Employment, for example, is greatest in the Rest-of-California. Intermediate demand employment refers to the demand associated with indirect employment, i.e. demand for goods and services provided by vendors to contractors created by the spending associated with HSR. It is the employment needed to satisfy demand for material inputs to the production of final goods.
- Local Consumption Demand Employment, e.g. restaurant and grocery store employment in places where construction happened. Local consumption demand is the demand for goods and services associated with induced employment; that is, the demand generated by workers based on income received from jobs associated with HSR. It is the employment needed to satisfy demand for consumer goods.
- Investment Activity Demand Employment, the employment needed to satisfy demand for capital goods, is also greatest in the Rest-of-California.
- Exports to Multiregions Employment, the employment needed to satisfy demand for a region’s goods and services from the other regions in a multi-area model, is substantial in Merced County and the Rest-of-California;
- Exogenous Industry Sales Employment, the direct amount of Industry Sales entered by the user into the Industry Sales/Exogenous Production Policy Variable and converted to Employees using Labor Productivity, is substantial in Madera and Fresno Counties.

These findings show that direct, indirect, and induced employment are each significant sources of employment in some regions of the model. For example, local consumption demand employment (induced employment) and Exogenous Industry Sales Employment (direct employment) are significant in the regions which are the focus of CP1 spending, i.e. Fresno and Madera Counties. The spillover effect represented by indirect employment,

as represented by Investment Activity Demand Employment and Exports to Multiregions employment, is greatest in Merced County and the Rest-of-California.

The largest effects by occupation are concentrated in:

- Management, business, and financial occupations [for example, commercial and residential real estate brokers],
- Sales and related, office and administrative support occupations [for example],
- Construction and extraction occupations, [for example, in steel mills and concrete supply companies].

With regard to occupations, the greatest employment effect overall, and generally for each region, will be in construction, office and administrative support positions, and management, business, and financial occupations. Employment in all occupational categories except military will experience some positive effect from additional HSR spending.

It is enlightening to relate a few of the case study findings discussed later in Chapter V to the results of the REMI analysis presented in this chapter. The researchers selected a few economic effect examples found via interviews with business managers whose firms either worked on CP1 or were forced to relocate because of it:

1. Civil engineering services firm WRECO hired three new professional employees to work on CP1. This hiring is reflected in rows labeled “Management, business, and financial occupations,” “Computer, mathematical, architecture, and engineering occupations,” and “Sales and related, office and administrative support occupations” in Table 1 of Supplemental Materials J (<http://transweb.sjsu.edu/research/1627>).
2. Holt Distributing & Manufacturing is a Fresno firm that makes and cleans heavy duty engine air intake filters, environmental filters, powder coating filters, and diesel particulate filters. This is reflected in the row labeled “Construction and extraction occupations” in Table 4 of Supplemental Materials J (<http://transweb.sjsu.edu/research/1627>).

Our best estimate is that CP1 will result in an additional 25,000 to 26,000 job-years over the period 2015–2029 at a cost of \$67,200 per job. This is about 25% more job-years than would be generated by transferring an equivalent amount of money to consumers. This falls within the range of job creation estimates from other major transportation infrastructure projects discussed in Chapter II, and below the estimates produced by the WSP analysis on the HSR project, but it should be noted that this current study uses a different methodology than the latter report as discussed in Chapter II.

VI. IMPACTS OF HIGH-SPEED RAIL CONSTRUCTION IN THE CENTRAL VALLEY: QUALITATIVE CASE STUDIES

While the economic modeling in Chapter IV can present a big picture understanding of the impacts of the HSR project within the Central Valley and the Rest-of-California, it is also important to recognize that this project is about the personal impact to individual people and individual companies. This chapter presents a series of case study vignettes that explore, on a personal level, how the HSR project has impacted individual companies in the Central Valley. These discussions highlight some of the opportunities, as well as challenges, that some companies have experienced. These vignettes are not intended to generalize across the wide range of companies and individuals touched by HSR in the Central Valley, but rather they serve to provide contextual understanding of the aggregate estimates produced through the REMI analysis.

The vignettes are divided into two major categories: (1) firms directly engaged in CP1-related work, and (2) firms relocated as part of the HSR project. Background research conducted via online sources (in-depth interviews with representatives from each firm) provided the data for this chapter. All surveyed parties agreed to be interviewed with full right of refusal for any reason. Where a named source is provided below, the party explicitly agreed to be named. A key goal in this portion of the research was both to validate aspects of the economic modeling approach used (i.e. concrete evidence of jobs created and the type of indirect and/or induced impacts experienced on the ground) as well as to personalize the HSR spending impacts and subsequent reinvestment in the Central Valley and California economy.

Although not initially part of the research plan, as a result of interviews with CP1 firms and the relocation case study examples, the researchers identified one additional area for focus in this chapter: workforce development. The last section of this chapter focuses on the CHSRA Community Benefits Policy and efforts of organizations such as the Fresno County Workforce Investment Board.

FIRMS ENGAGED IN CP1-RELATED WORK

A wide variety of California firms have been engaged in CP1-related work, as shown in the following list issued by the Authority.³⁶ This list may not be 100% exhaustive, but it does showcase the wide range of firms and industries involved. The list shows the name of the firm, as well as the product or service provided:

1. 2R Drilling, Inc Stem Auger Drilling, Mud Rotary Drilling & Rock Coring
2. Aardvark Biological Services, Wildlife Surveying
3. Ace Fence Company, Fencing
4. Alert Medical Training, Preventive Health & Safety
5. Alert-O-Lite Construction, Safety Equipment
6. American Crane Rental, Crane Rentals
7. American Refuse, Waste Management
8. Applied Earthworks, Inc, Excavating
9. Area West Environmental, Inc, Environmental Assessment
10. Associated Traffic Safety, Safety Equipment Supplier
11. BBL Tatum Trucking, Trucking
12. Bess Test Lab, Utility Contractor
13. Blair, Church & Flynn Consulting Engineers, Engineering Services
14. BMA Construction Engineer, Inc, Construction Engineering
15. Bond and Kennedy, Inc, Project Management
16. Bradley Tanks, Inc, Liquid & Debris Tank Rentals
17. Cal Lowbed Service, Trucking
18. Canyon Fork Ace Hardware, Hardware Supplier
19. Capo Projects Group, Construction Services
20. CH Bull Company, Hydraulic Jacks
21. Charter Industrial Supply, Hydraulic Equipment
22. CHS Consulting, Engineering Services
23. CMG Hydroseeding, Hydroseeding, Drill Seeding, and Erosion Control Solutions
24. Commercial Exteriors, Construction Services
25. Constar Supply, Equipment Supplier
26. Contact Hoist & Rigging, Ropes
27. Curtis Electric Construction, Inc, Electrical Engineering
28. Dave's Trucking, Trucking
29. Delta One Security, Security Services
30. DeWalt Corporation, Engineering Services
31. Dillard Environmental, Trucking
32. Direct Safety Solutions, Construction Safety Equipment
33. Earth Mechanics, Inc, Geotechnical & Earthquake Resiliency
34. ERTEC Environmental Systems Erosion, Sediment & Wildlife Control Systems
35. EXARO Technologies, Engineering Services
36. Fresno Wire Ripe & Rigging, Wire Rope & Rigging
37. G&C Equipment, Equipment Supplier
38. Garavaglia Architecture, Inc, Architectural Services
39. Hoffman Electronic Systems, Security Systems
40. Hunsaker Safety & Sign, Construction Safety Equipment
41. I-5 Rentals, Heavy Equipment Rental
42. IDC Engineers, Engineering Services
43. Innovative Concrete Solutions, Concrete
44. IS Architecture, Architectural Services
45. James Transportation Group, Engineering Services
46. Jet Drilling, Well Drilling
47. JMA Energy Company, Civil Engineering Services
48. Jones Heavy Haul, Trucking
49. JRP Historical Consulting, Environmental Assessment Services
50. Katch Environmental, Mold Removal Services
51. Kehoe Testing, Cone Penetration Testing and Direct Push Sampling
52. Lalonde Equipment, Equipment Rental
53. Landavazo Bros. Inc, Demolition and Recycling
54. LCP Tracker, Construction Site Compliance
55. Lee Andrews Group, Public Relations
56. Leon Environmental, Environmental Services
57. Madco Electric, Electrical
58. MARRS Service, Inc, Engineering Services
59. Martinez Steel Corp, Steel Fabricator
60. Matson Alarm Company, Security Systems
61. Matt-Chlorr, Inc, Water Disinfection
62. MGE Engineering, Engineering Services
63. Mid Valley Engineering, Inc, Engineering Services
64. Middle Earth Geotesting, Environmental Cone Penetrometer Testing
65. MJ Avila, Inc, Construction Services
66. Moore Twining Associates, Inc, Engineering Services
67. Mountain Pacific, Inc, Civil Engineering Services
68. Oliveira Fence, Fencing
69. OPAC Consulting, Structural Engineer
70. Outback Materials, Concrete, Rock & Sand Supplier

- | | |
|---|---|
| 71. Parrish Hansen, Structural Engineering | 87. SPER Contracting Corp., Construction Services |
| 72. Pipe Jacking Unlimited Inc, Pipe Supplier & Trenchless Construction | 88. Super Seal & Stripe, Paving |
| 73. Pirhana Pipe & Precast, Pipe Supplier | 89. Taber Drilling, Drilling |
| 74. Prime Construction Company, Inc, Construction Services | 90. Technicon Engineering, Engineering Services |
| 75. PTS Rentals Power, Generator & Air Compressor Rental | 91. Terra Environmental, Environmental Services |
| 76. Rail Pros, Inc, Rail Construction Management | 92. The 111th Aerial Photography, Aerial Photography |
| 77. Ruperty Construction, Supply Equipment Supplier | 93. Touch of Green Landscape, Landscape Design |
| 78. Safety Striping Services, Paving | 94. UNICO Engineering, Construction Services |
| 79. Saf-T-Co Supply, Pipe Supply | 95. USC Supply, Building Materials |
| 80. Salem Engineering, Engineering Services | 96. Valverde Construction, Construction Services |
| 81. Sequoia Equipment Company, Industrial Equipment Supplier | 97. Ventura Consulting Group, Strategic Advisory |
| 82. Shasta Welding Supply, Welding Supply | 98. Verux, Strategic Advisory |
| 83. She Marine Veteran, Supply Equipment Supply | 99. Western Traffic Supply, Construction Safety Equipment |
| 84. Sierra Lock and Glass, Lock Supply | 100. Wild Electric, Electrical Engineering |
| 85. SoCal Drilling, Well Drilling | 101. WKE, Inc., Engineering Services |
| 86. Soils Engineering, Construction Services | 102. Wreco, Inc, Civil Engineering Service |

Case Studies on CP1 firms

The researchers selected a sample of firms from a list provided by CHSRA that included the dollar amount of work or materials invoiced by each firm for its CP1 work. Firms with the largest amount of work invoiced in dollars were chosen, while at the same time skipping over firms – mostly small and disadvantaged businesses – that had already been the subject of earlier case study presentations from the Authority that described impacts. The team researcher on this part of the project worked through the list until he had a predetermined number of firms, eight, to provide illustrative example information. The researcher obtained interviews with seven; one firm declined to make a representative available despite multiple calls. The researcher confirmed that all of the interviewed firms engaged in work on CP1. Five additional firms with impacts resulting from forced relocations were provided by the Fresno County Economic Development Corporation as illustrative of good and bad outcomes, and following calls seeking interviews, three provided information, while two did not respond to multiple calls. All of the ten case study firms across the two samples provided information consistent with the researcher’s experience with business issues and with news accounts of impacts, although the selection methodology is not claimed to have found all possible economic impacts of CP1 nor a statistically representative array of opinions about impacts. The following does provide some details on the ground that the economic analysis in the first part of this report could not have possibly picked up.

WRECO

Company web site: <http://wreco.com>

WRECO is a civil engineering services firm headquartered in Walnut Creek, CA. The firm was founded in 1995 and provides communities throughout California with solutions for environmental compliance, geotechnical engineering, and water resources management. WRECO is classified as a Small Business and a Disadvantaged Business Enterprise. Approximately \$524,000 has been billed to the HSR project for drainage design, hydrologic and hydraulic analyses, bridge design hydraulic studies, and floodplain impacts analysis through a subcontract to TPZP, the main design-build firm for CP1. Most of the contracted work was carried out in WRECO's own offices, although some field visits were necessary. According to Garrett Low, a senior associate at WRECO interviewed for this research, the firm averaged three salaried FTE employees doing the HSR project work. At the peak of activity, it had 8 to 10 FTE engineers working on CP1 tasks. This contract provided about 15% of the firm's revenues over the past 3 years. WRECO hired 3 new people for CP1 who have been retained by the firm after completion of CP1 work. The firm ramped up from 50 to 70 FTE staff during this period, not all of whom worked on CP1. Low noted that the work was very good for the firm, saying that it was considered an "anchor, sustaining project" balanced with other projects. The firm is competing to work on extensions and is hopeful of winning more work.



Figure 16. WRECO Engineers

Source: WRECO, Company Facebook Page. Accessed 3/28/2018
from: <https://www.facebook.com/WRECO-243321372363359/>

Sumiden Wire Products Corporation

Company web site: <http://sumidenwire.com>

Sumiden Wire Products Corporation is a manufacturer of specialty steel products. The firm is a subsidiary of a Japanese company, Sumitomo Electric Group, but all of the product produced for the CP1 work was manufactured in Stockton, California. The project database shows that this firm billed approximately \$910,000. The product made for CP1 is seven-wire prestressed concrete cable that goes first into a third-party warehouse and then subsequently into the interior of concrete girders made in Fresno by another firm, ConFab. The hot rolled wire rod, out of which the cable strands are drawn out by Sumiden, is made by steel mills located in the USA, a requirement of the Authority. Cable inserted by another firm into concrete girders and cable made by Sumiden from wire rod coming from

steel mills are examples of business-to-business transactions that are generated by the HSR project. During the 36-month period of making this cable, Sumiden was running at 60 to 70 percent capacity, and the firm's Vice President of Sales, Jeff Feitler, indicated that the CP1 steel cable was worth a few additional percentage points of utilized capacity. Employment at Sumiden was not increased for this project, but the firm appreciated having this order in a "difficult market" for steel products and looks forward to continuing as part of the supply chain for the HSR project.

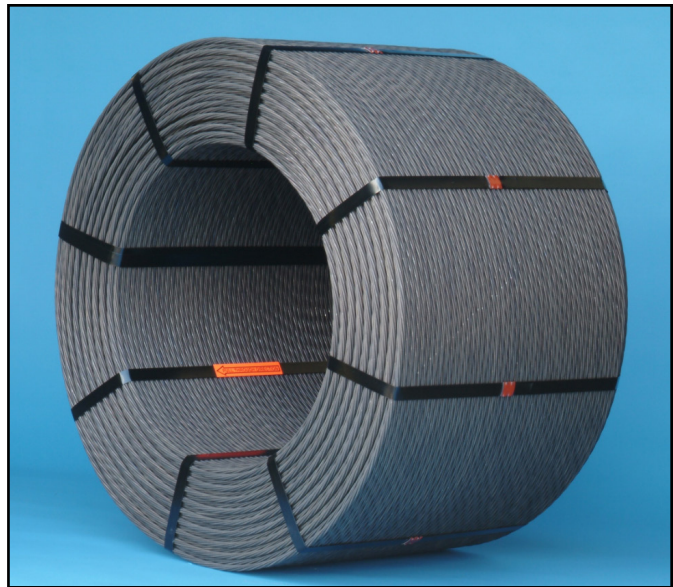


Figure 17. Sumiden Seven-Wire Prestressed Concrete Steel Strand

Source: Sumiden Wire Products Corporation, PC Strand. Accessed 3/28/2018 from: <http://www.sumidenwire.com/products/pc-strand/>

Skyline Steel

Company web site: <http://skylinesteel.com>

Skyline Steel is a steel foundation supplier serving the U.S., Canada, Mexico, the Caribbean, Central America, and Colombia. It's a wholly-owned subsidiary of Nucor Corporation, the largest producer of steel in the United States. CHSRA requires that all steel in the project is American-sourced, and this firm is an example of a domestic source. For the HSR, Skyline is estimated to have provided bearing piles and retaining walls that are part of the civil construction, with the record showing invoicing of approximately \$2,039,000. This firm reported no staff growth and no significant impact on the firm from this materials order, but an anonymous source within the firm said the company was happy to have the order for materials. There was no mention of the firm's involvement in the HSR project on the firm's website, and in fact, the firm is not mentioned anywhere on the California high-speed rail website; however, the manager contacted did confirm that Skyline Steel provided material for CP1.



Figure 18. Steel Frame That Will be Part of a Poured Concrete Pillar for the San Joaquin River Viaduct

Source: California High-Speed Rail Authority. <https://www.flickr.com/photos/hsrcagov/> Accessed January 11, 2018.

Earth Mechanics, Inc.

Company web site: <http://earthmech.com>

Earth Mechanics, Inc. is a geotechnical investigation and analysis firm in Fresno which is classified as a Small Business and a Disadvantaged Business Enterprise. According to the firm, “EMI provided surface explorations and laboratory testing necessary to supplement existing geotechnical data along the alignment in order to provide adequate information for geotechnical engineering analyses, geologic and seismic hazard evaluations, and preparation of geotechnical recommendations pertaining to design and construction of bridge structures, mechanically stabilized earth walls, and pavement sections.”³⁷ This firm billed approximately \$1,233,000 for their CP1-related work. Hubert Law, vice president and CFO of the firm, reports that between 10 and 15 people worked on CP1 tasks, and three new FTE engineers were hired and retained as a direct result of the HSR work. As an example of the type of economic spillover effects that can occur within a local economy, Law stated that the company rented a house near the construction site for two years at \$1,500 per month.

Blair, Church & Flynn Consulting Engineers

Company web site: <http://bcf-eng.com>

Blair, Church & Flynn Consulting Engineers is a Small Business and a Disadvantaged Business Enterprise located in Clovis, CA, that does utility relocation design work. As part of CP1-related work, the company produced documents that guided field work for implementing the utility relocations, billing approximately \$2,389,000. According to Adam Hold, Chief Financial Officer for the firm, CP1 contributed to the firm's growth and led directly to the hiring of five FTE engineers who have been retained following conclusion of the CP1 work. Some were relatively recent graduates who used the cash flow from working in a new job to pay down student loans. Holt also noted that competition for architectural and engineering professionals has noticeably increased in the Central Valley, as has the demand for qualified construction workers, likely as a direct result of the HSR project.



Figure 19. Utility Relocation for the HSR Project

Source: Blair, Church & Flynn, "Transportation" Accessed March 30, 2018
from <http://bcf-engr.com/markets/transportation/>

PSOMAS

Company web site: <http://Psomas.com>

PSOMAS is a surveying firm with 16 offices located throughout California, Arizona, and Utah. Three crews were assigned to the CP1 work with two to three staff per crew. In addition, three local hires were made of temporary workers who performed lower skill tasks. The project database shows that this firm billed approximately \$419,000. A manager who asked to remain anonymous provided information that allowed the researchers to

estimate that the crews used around 320 motel nights for lodging over two months of work in cases where PSOMAS workers did not live near where the surveying was taking place. This purchase of motel accommodations is an example of the project's economic impact accruing to a local visitor services firm, which in turn leads to additional impacts because motel cleaning and maintenance staff or contractors have hours of employment resulting from high-speed rail construction.

Willdan Group

Company web site: <http://willdan.com>

Willdan Group is a NASDAQ-listed nationwide provider of professional technical and consulting services. "In late 2013, Willdan formed and staffed an Infrastructure Division to pursue larger projects, primarily in transportation," according to the firm's website.³⁸ This division won \$789,000 in subcontracts to assist AT&T in utilities relocation associated with CP1. Daniel Chow, CEO of the firm, reported that this required the assignment of three FTE engineers to this work, one of whom was a new hire for the project. Two of these individuals have stayed with the firm, while one was a voluntary resignation for a new position in another company. The staff lived in rented apartments in Fresno. As of this writing, the firm is not lined up for any follow-on work for the CHSRA.

Analysis / Trends from Case Studies on CP1 firms

The seven firms highlighted in this section are only a small sample of the total number of firms who have worked on CP1-related tasks through either direct contracts with CHSRA or through a subcontract with a direct contractor (e.g. TPZP). A key goal was to better understand, at an individual firm level, how working on the HSR project impacted firms. Did it lead to additional hiring, and were those individuals retained after the CP1 contract was complete? What might have been some of the typical spillover economic impacts in the local area from firms working on the project? Here, we briefly discuss some of the themes that emerged from conversations with these firms.

None of these firms, whether large or small, characterized their work on the HSR project to be more than a quarter of their workload, and sometimes it was much less. Most of the work was done with employees already on staff, although some additional hiring was reported. Across all of the seven firms, 15 new hires were reported, most of whom were retained. In addition, in three cases, local accommodations in Fresno for staff were acquired (rental units and/or hotel accommodations). Overall, the interviews did not reveal any other patterns of economic impact aside from the direct new jobs created and the spillover into the housing and hotel industry. It is certainly possible that these patterns are similar across other firms working on CP1. In addition, as identified in the REMI analysis, the CP1 spending is estimated to lead to economic impacts across a wide range of industries including commercial and residential construction; wholesale and retail of consumer-focused industries such as cars, furniture, and personal care products; and services including education, healthcare, and entertainment.

The economic linkages that have been created in CP1—including personnel flows into employment, material movements in supply chains running from factories to construction sites, and secondary impacts from workers spending their wages in the community—are all incorporated in the modeling in prior chapters. This modeling covers the activity of all firms, not just the ones in the limited sample described in this chapter.

The research team found no indications in the interviews that managers of these firms thought of their companies as participants in a specific “high-speed rail construction industry” emerging in the Central Valley, even though this is what was going on as a result of CP1 and the follow-on phases. What the firms were accomplishing in CP1 was markedly similar to the civil engineering and materials supply for a highway construction project, on which these firms were accustomed to working.

While our methodology for selecting firms did not prioritize choosing small firms, three of the firms in our sample of seven turn out to be characterized by the CHSRA as small businesses. Including small businesses in the contract work has been a priority of the Authority, and as a result, across all of the high-speed rail work, many small businesses have been engaged. The Authority reported in January 2018 in *The Sacramento News & Review*,

“Hundreds of California small businesses are planning, designing and constructing the high-speed rail system,” Massie noted. “Our Small Business Program has an aggressive 30 percent participation goal by small businesses. ... Since implementing those goals in 2012, we’ve paid more than \$250 million to certified small businesses who have joined the project.”³⁹

RELOCATION CASE STUDIES

In terms of visibility in the community, business relocations due to the planned route of a major infrastructure project can have significant economic impacts, just like the construction itself. The economic impacts are fully included in the modeling described in the earlier part of this study.

Relocations can be controversial and challenging: there are financial, emotional, as well as logistical barriers that are often difficult to manage. They also required significant coordination and collaboration with multiple entities. In order to explore some examples of HSR project-led relocations, the researchers obtained information from the Fresno Economic Development Corporation in order to conduct in-depth interviews. According to media reports, “the High-Speed Rail Authority has successfully relocated 178 Fresno businesses so far, and 90-percent have stayed in the city.”⁴⁰

Case Studies on Relocated Firms

Three Fresno firms who relocated due to the HSR project were interviewed as part of this research. Every relocation is unique, so while these firms’ experiences should not be generalized across all relocations, they do serve to highlight some of the outcomes resulting from a relocation. In some cases, firms have taken this opportunity to expand and/or modernize their business, while others have faced some challenges.

It is important to recognize that the relocation process can be stressful. Even if a business is “successfully relocated,” the process carried out probably encountered bumps along the way as offers, negotiations, and decisions occurred.

*Modern Custom Fabrication*⁴¹

Modern Custom Fabrication (MCF) is an 80-year-old firm that fabricates tanks for industrial sites in a 78,000 square-foot factory in downtown Fresno. The firm needed to relocate because the land was necessary for the HSR project. The process involved local government and the Fresno County Economic Development Corporation (FEDC), as well as attorneys and independent relocation consultants engaged by MCF, and the High-Speed Rail Authority’s right-of-way acquisition and relocation agents.

After a financial settlement was reached with CHRSA, MCF commenced to develop its option for a new location. The firm evaluated several out-of-town sites, including Las Vegas, to determine the most cost-effective and feasible location for both relocation and expansion. Issues considered included site dimensions, permitting timelines, business incentives, energy costs, water and sewer infrastructure, and logistics.

After considering all available options, MCF went back to examining the possibilities within the City of Fresno, where their employees make their home, and identified a site that met their requirements and could accommodate their future growth. MCF will be moving into a new 100,000 square-foot facility located in southeast Fresno.



Figure 20. Groundbreaking for Future Home of Modern Custom Fabrication

Source: <https://pbs.twimg.com/media/DIGQrpkVwAAr55v.jpg>

MCF Plant Manager Jim Gray noted the importance of cooperation with the City in helping aspects of the relocation go smoothly. There was cooperation among multiple city departments, especially the planning department, which has personnel designated solely to high-speed rail related projects.

The city also offered an incentive package, which included fee waivers and expedited permitting. Other incentives included a 30 percent reduction in electricity costs over five years through Pacific Gas & Electric Co., which awarded MCF the Economic Development Rate.

As another example of economic spillover, MCF has engaged SPAN Construction, located in Madera, CA, to design and build a new state-of-the-art facility. This upgrade will increase MCF's operational productivity. Ground was recently broken on the new site.

*Coffee Break*⁴²

Company web site: <http://www.coffeebreakservice.net>

Coffee Break is Central California's oldest full-service office refreshment company. This is a family-owned distributor of coffee, tea, packaged water, and other employee break room supplies and equipment with annual sales of \$4.5 million. The firm had been located for decades in a 13,000 square-foot warehouse which was in the pathway needed to build a street bridge over the future HSR trackway.

Coffee Break has experienced a number of challenges as a result of the relocation process, primarily as a result of delays related to moving into a new facility. In 2016, Coffee Break was compensated for the sale of the original location, and a suitable new building was found. However, this new facility needed a long period of City plan review and permit issuance, which led to significant renovations and upgrades to meet present day code standards, such as requirements on the exterior sidewalks to satisfy provisions of the Americans with Disability Act (ADA). The new building was not ready when the original building was evacuated. The firm moved into a temporary facility, provided rent-free by the CHSRA.

While operating out of the interim facility, the cost of the renovation of the new building mounted up, such as costs associated with the sprinkler system and a new roof, leading to additional expenses. To be sure, Coffee Break has been provided compensation in this overall relocation from the sale of the old building, along with support for additional spending to purchase the new location. However, additional expenses have been incurred, and this spending, triggered by business relocation requirements and its aftermath—both fully compensated and unanticipated additional expenses—provides examples of further economic impacts. The economic modeling in Chapter IV accounts for these kinds of economic impacts, in addition to the costs of design and construction.

*Holt Distributing & Manufacturing*⁴³

Company web site: <http://holtdist.com>

Holt Distributing & Manufacturing has been a family owned and operated business for over 38 years. Products include manufacturing and cleaning heavy duty engine air intake filters, environmental filters, powder coating filters, and diesel particulate filters.

Because of HSR right-of-way land requirements at Holt's former location, the firm relocated from its 14,000 square-foot leased location, occupied since 1978, and transitioned to a 20,000 square-foot location it renovated and now owns. According to Patty Holt, Office Manager, the firm recognizes that there can be benefits in owning rather than leasing, but it had not been the firm's first choice to tie up capital in real estate. Unfortunately, no suitable location was available to rent at the time.

The firm has borne expenses that were above and beyond the relocation compensation provided. This is not unusual when government agencies are practicing eminent domain in property acquisitions for critical infrastructure. Government construction projects have right-of-way budgets and legal requirements on what can and cannot be compensated.

According to Holt, the firm's employment level has dropped down to six full-time employees and one part-time employee, from a pre-move level of seven full-time and one part-time.

Overall Impact on Real Estate

Beyond individual firm relocations and the need to find new facilities, there can be other real estate-generated economic impacts due to the HSR project. The research team interviewed Nick Audino of Pearson Realty, a leading industrial real estate broker in Fresno. According to Audino, approximately 100 relocations he observed due to the HSR project in Fresno, coupled with the overall economic recovery in the region, created a one-time spike in demand for business sites that drove up prices. At the same time, he observed no noticeable rise in the number of site sales to firms coming from outside the region to respond to the opportunities directly resulting from the CP1 construction activity.

Beyond relocations made necessary to clear the HSR right-of-way, there has been limited evidence of speculative real estate development in anticipation of a future HSR station in Fresno, with one notable exception. Real estate developer Sevak Khatchadourian, based in Beverly Hills, is focused on a new, mixed-use downtown development near the future train station, at least partially because of the attractiveness of the future rail transportation mode to future tenants. Khatchadourian participated on a panel in the 2012 Rail~Volution Conference in Los Angeles when HSR station area development was discussed.⁴⁴ He owns the tallest building in Fresno, the Pacific Southwest Building, which he bought in 2011 as future high-speed rail through Fresno was coming into view as a reality. This building is within walking distance of the likely station location. He has planning and renovation work underway in this building to create residential lofts, office space, a rooftop restaurant, and a ballroom.⁴⁵

Relocation Assistance in Fresno⁴⁶

The Fresno Economic Development Corporation (FEDC) was founded in 1981 to facilitate business development in the County through assistance in business expansion, attracting new businesses, and retaining existing businesses in the region. FEDC was funded by the CHSRA to start a program to help facilitate the needed relocations for the project. FEDC describes this work as follows:

The Fresno County EDC HSR Business Support Program serves as one of the largest job retention efforts in our region. There are over 300 businesses impacted along the alignment representing thousands of jobs. Our team works diligently to retain those jobs here in Fresno County. We offer an array of business services that include: site search and selection, acquisition assistance, business and financial planning, and permitting and entitlement assistance with the City and County of Fresno.⁴⁷

According to FEDC, its Business Support Program hired five “business services” professionals who were individually assigned to 85 relocation cases. The main goal was to retain the relocated businesses within the limits of Fresno County, whether large or small. The goal was largely achieved, with a reported 96% of businesses retained, although some businesses decided to end operations, and one moved to a neighboring county. FEDC reports that “over 30% of clients have expanded their building footprint.”⁴⁸ This worthy program of active business support obviously generates more sustained local economic activity than would be the case if property acquisitions for the high-speed rail right-of-way were turned into owner resources for emigration and retirement expenses.

Analysis/Trends from the Relocation Case Studies

As can be seen from the examples described above, relocations are challenging and often require negotiation and collaboration with multiple entities. Although relocation payments are always represented as fair market value, there can be additional expenses, either due to a choice the business makes to invest and expand their business, or due to unforeseen circumstances outside the scope of defined relocation expenses. As with most negotiations, the two parties often have to meet in the middle somewhere between what each side deems as desirable. With critical infrastructure construction by governments, there can be an added complication because the use of public funds cannot legally go beyond the scope of defined relocation expenses. In some cases, relocation results in unanticipated private investments drawn from the owners’ own resources. There was at least one case in Fresno of a business in the path of the train tracks in which the owner decided to close shop and retire. After moving occurs, there are some relocated businesses that are going to see higher future sales, and some that will see less. Some businesses will be able to expand, and there are likely to be contractions as well. Examples of these circumstances were seen across the three cases discussed here.

The *process* of business relocation generates economic activity in firms and non-profits that facilitates the various transactions needed to assess value, sell facilities within the right-of-way, and move to new facilities. The dollars required for these sub-processes are part of all of the HSR scenarios for the economic modeling in this study. The modeling also

forecasts the future economic outcomes following the relocations, which amount in sum to a significant reshaping of the geography and economy of the Central Valley even before the trains start operating with paying passengers. There will be several distinct multi-year economic eras in the years ahead: the period before the high-speed trains start running; a period when the trains are running in initially limited service; and then finally when trains are running all the way into the major terminus cities to the north and the south of the Central Valley.

The general pattern the FEDC achieved in having almost all of the relocated firms re-open within the boundaries of the same county bodes well for a pattern of sustainable economic growth in the local region. Relocation is a challenge under the best of circumstances, but seeing so many choose to remain local and reinvest in the local economy is a good sign. This pattern will then be reinforced by the primary and secondary economic results from payments made to firms and workers for the demolition and rail-bed construction activity associated with CP1. This report does not forecast the economic results from the future operation of the trains, but one can see from only the sample of activity described in this chapter that a considerable economic impact is generated ahead of the trains. The economic modeling is consistent with what the case studies indicate.

CONSTRUCTION HIRING SUPPORTS SOCIAL GOALS

Another noticeable category of impacts due to CP1 spending can be seen in the investment in local workforce development activities in the local region. As seen in Chapter IV, construction workers were the largest category of employment generated through CP1 spending. In 2012, the CHSRA adopted a Community Benefits Policy that put in place specific goals related to construction-worker hiring for the project. Goals were established for contractors in the early phases of construction to hire disadvantaged employment candidates in disadvantaged communities of high poverty or unemployment. Disadvantaged workers include homeless people, high-school dropouts, veterans, the long-term unemployed, and those in other categories described below.⁴⁹

The Fresno County Workforce Investment Board (WIB), in cooperation with other organizations, offered a six-week pre-apprenticeship training program to get disadvantaged candidates for employment ready for apprenticeship opportunities in construction. The research team interviewed Patricia Barry, a vocational counselor for the WIB who was acquainted through case work with approximately 300 entry-level construction workers who were provided this job-readiness and entry level skills training to support the Community Benefits Policy. She reports that the program achieved a 96% graduation rate and a strong record of the trainee graduates obtaining first-time employment with firms working on CP1-related tasks. She provided these examples of successful employment scenarios:

- A former prison inmate whose earnings provided a basis for reuniting with his wife and family, and providing dental care for his daughter.
- A formerly homeless individual who was able, through HSR employment, to rent an apartment, buy a personal vehicle, and pass the test for a commercial drivers' license, which then led to a work assignment driving trucks.

- A former stay-at-home single mother with two children who was able to gain employment as an electrical technician, using earnings to put her children into after-school daycare. She was then able to buy school supplies for them rather than continuing her past habit of accepting donated supplies.
- A former member of an allegedly criminal gang who, through training and employment, was able to move out of a economically-struggling community into a new community, attain gainful employment, and achieve enrollment in a junior college to advance himself further.
- Another adult male individual who, through training and employment, was able to leave home, where he had been supported by his parents. Instead, he was able to begin to financially support his parents.

Figure 21 shows one of the Pre-Apprenticeship Training classes offered by the WIB at graduation.



Figure 21. Graduation Ceremonies for a Pre-Apprenticeship Training Program in Modesto

Source: California High-Speed Rail Authority. <https://www.flickr.com/photos/hsrcagov/> Accessed January 11, 2018

The Community Benefits Policy sets quantitative goals for the percentage of work hours in CP1 construction jobs that have to be performed by disadvantaged or targeted workers. Specifically, 30% of all hours worked were to be performed by “National Targeted Workers” with at least 10% of hours worked performed by “Disadvantaged Workers” (see definition below).⁵⁰

As described by the Authority:

Targeted worker: is an individual whose primary place of residence is within an economically disadvantaged area or an extremely economically disadvantaged area in the United States, or a disadvantaged worker.

Disadvantaged worker: an individual who, prior to commencing work on the high-speed rail project, meets the income requirements of a Targeted worker and faces at least one of the following barriers to employment: (1) being a veteran; (2) being a custodial single parent; (3) Receiving public assistance; (4) lacking a GED or high school diploma; (5) having a criminal record or other involvement with the criminal Justice system; (6) suffering from chronic unemployment; (7) emancipated from the foster care system; (8) being homeless; or (9) being an apprentice with less than 15 percent of the required graduating apprenticeship hours in a program.

The Authority issued news in a tweet on January 11, 2018 that “there are currently 1,215 workers helping to build High-Speed Rail in Construction Package 1 between Madera and Fresno.” The CHSRA 2017 Sustainability Report states that as of September 30, 2017, 666,000 construction hours have been expended on CP1. That number rose to 820 thousand by the end of January 2018. The cumulative percentage of targeted worker hours reached 69%, and the cumulative percentage of the hours of targeted workers who are disadvantaged stood at 28%. These percentages are well above the target figures of 30% for targeted and 10% for disadvantaged workers.⁵¹

VII. CONCLUSION

The first phase of California HSR development, captured in this analysis, will invest a total of \$2.654B into the economy. Nearly half (\$1.283B) was for the design-build contract, while the rest encompassed smaller construction activities (i.e. SR-99 and the Madera Extension), right-of-way costs (\$600M), as well as managerial and project development expenses.

That investment has led (and will continue to lead) to thousands of additional jobs, located primarily in the Central Valley at a cost-per-job that falls within the range of other major transportation infrastructure investments. Using the REMI Model, a number of alternative scenarios were examined focusing on the estimated full-time equivalent job-years to be generated through 2029. Table 7 presents the estimated cost-per-job-year for each of the scenarios considered.

Table 7. Cost per Job-Year Estimates Based, by Alternative Scenarios

Scenario Name	Aggregate Job-Years Estimate		Cost per Job-Year ^a
	FTE Adjustment Factor 0.80	FTE Adjustment Factor 0.83	
HSR Base Case	25,231.2	26,177.4	\$68,410-\$65,937
Raw FCP Case	29,214.4	30,309.9	\$76,299-\$73,542
Base Case Real 1%	27,178.4	28,197.6	\$63,959-\$61,648
Base Case Real 2.5%	26,776.8	27,780.9	\$64,014-\$61,700
Expenditure-equivalent Transfer Payments	19,891.2	20,637.1	\$86,775-\$83,639

^a Based on CP1-related spending of \$2.654B.

As shown in Table 7, estimates for the cost per job-year vary depending on the assumptions one considers in the modeling. However, the ranges are in line with estimates from the literature on Recovery Act spending discussed in Chapter II and fall below the figures calculated by WSP's analysis of the HSR project (specifically, the WSP analysis estimated cost per job-year of \$97,458–\$115,578, but considered a different overall range of costs).

The REMI Model suggests that direct, indirect, and induced employment are all significant for various regions in the model. The direct and induced effects are greatest in the regions which are the focus of spending—Madera and Fresno Counties—while the indirect employment effects are greatest in Merced and the rest of California. In terms of occupations, the main effects are in construction-related occupations and management.

The case study vignettes presented here are consistent with an ongoing series of reports from the CHSRA that have documented numerous cases of new business activity, new employment, and revitalized lives because of work being done that is necessary to build this railroad. The Authority has previously reported that the unemployment rate in Fresno County, where most CP1 activity is occurring, has dropped to “under 10% for the first time since the Great Recession,”⁵² another sign of a positive economic impact of the first phase of HSR construction. The modeling carried out in this study suggests that the economic impacts will continue beyond the end of the CP1 construction, without regard to later

packages that are already underway. Furthermore, the modeling provides the groundwork for justifying the belief that more construction activity in follow-on phases will lead to further economic impacts, although this study did not aim to forecast impacts beyond CP1.

The Authority's stated determination—highlighted continuously and with much detail in the Authority's publications—that construction would provide jobs to disadvantaged geographies, disadvantaged firms, and disadvantaged individuals was born out anecdotally as being achieved in the research reported here, although auditing performance toward this worthy goal was outside the scope of this study.

Most of the managers in the firms surveyed for this report stated or implied that they were hopeful for additional contracts beyond the work they performed in CP1. The research team's sense of the owners and employees of the firms forced into a disruptive and sometimes expensive process of relocation because of HSR's future track location is that they see themselves as participants in an investment that truly pays off *only* when the high-speed passenger trains are running. The hundreds of men and women who have gone through weeks of training and finally entered the civil construction industry to go beyond their "disadvantaged" status for the first time are undoubtedly hoping that the jobs they enjoy now will continue.

ABBREVIATIONS AND ACRONYMS

ADA	Americans with Disability Act
ARRA	American Recovery and Reinvestment Act
C&E	Contracts and Expenditures
CHSRA	California High-Speed Rail Authority
CP1	Construction Package 1
CY	Calendar Year
DB	Design-Build
EIA	Economic Impact Analysis
FCP	Funding Contribution Plan
FEDC	Fresno County Economic Development Corporation
FRA	Federal Railroad Administration
FTE	Full-Time Equivalent
FY	Fiscal Year
HSR	California High-Speed Rail
IMPLAN	Impact Analysis for Planning
MCF	Modern Custom Fabrication
RATB	Recovery Accountability and Transparency Board
REMI	Regional Economic Models, Inc.
RIMS II	Regional Input-Output Modeling System
RoN	Rest-of-the-Nation
RoW	Right-of-Way
TPEF	Total Project Expenditures with Forecasts
US	United States
WIB	Fresno County Workforce Investment Board

ENDNOTES

1. WSP, 2017, "2016 Economic Impact Analysis Technical Supporting Document," California High-Speed Rail Authority, Accessed May 21, 2018 from http://www.hsr.ca.gov/docs/brdmeetings/2017/brdmtg_071817_Item4_ATTACHMENT_Economic_Impact_Technical_Memorandum.pdf.
2. Judith Cummings, 1984, "Plan for High-Speed Train on West Coast Scrapped," *The New York Times*, Nov. 20, 1984. Accessed January 26, 2018 from <http://www.nytimes.com/1984/11/24/us/plan-for-high-speed-train-on-west-coast-is-scrapped.html>.
3. Holian and Kahn (2013, pp. 20–22) describe Prop 185 from 1994 which failed but proposed to create formal state backing for the study of two "fast" San Francisco to Los Angeles rail lines, a coastal route and a Central Valley route. Holian and Kahn (2013) also describe Prop 1A from 2008 and the California HSR project in general from a voting perspective, documenting that high-speed rail in California has been the subject of at least two state-wide contests in direct democracy. See *California Voting and Suburbanization Patterns: Implications for Transit Policy*: <http://transweb.sjsu.edu/project/1105.html>.
4. CHSRA, 2016, "Connecting and Transforming California, 2016 Business Plan," Accessed December 12, 2017 from http://www.hsr.ca.gov/docs/about/business_plans/2016_BusinessPlan.pdf.
5. CHSRA, 2018. "High-Speed Rail Project Sections." Accessed July 30, 2018 from http://www.hsr.ca.gov/Programs/Statewide_Rail_Modernization/project_sections/index.html
6. This document, available at http://www.hsr.ca.gov/docs/about/funding_finance/funding_agreements/FRA-HSR-0009-10-01-02.pdf, lists SF-SJ at 50 miles, SJ-M at 120 miles, M-F at 60 miles and F-B at 115 miles. The 122 miles quoted in the text (from http://www.thehamiltonreport.com/downloads/Denham-2015-11-13-CHSR-Grant-Update-Status-Briefing_FINAL.pdf on p. 2) and accounts for the fact that the initial construction segment ends north of Bakersfield, but extends into Madera.
7. CHSRA, 2012, "Feds Approve High-Speed Rail Route from Merced to Fresno," Press Release, Accessed December 12, 2017 from <http://www.hsr.ca.gov/docs/newsroom/archives/Press%20Release%20Record%20of%20Decision%20for%20Merced%20to%20Fresno.pdf>.
8. CHSRA, 2015, "High-Speed Rail Authority Hosts Official Groundbreaking Ceremony," Press Release, Accessed December 12, 2017 from http://www.hsr.ca.gov/docs/newsroom/jan_2015_Groundbreaking_Press_Rel010615.pdf.

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 10. Bill Dupor, n.d. "Bill Dupor's Research Site: Academic Articles," Accessed December 12, 2017 from <https://billdupor.weebly.com/academic-articles.html>.
 11. The Economic Impact of the American Recovery and Reinvestment Act Five Years Later. Final Report to Congress. February 2014, page 3. https://obamawhitehouse.archives.gov/sites/default/files/docs/cea_arra_report.pdf. We had the XLS version but it is also publicly available.nts, and this is beyond the scope of what is being discussed right now.
 12. Bill Dupor and M. Saif Mehkari, "The 2009 Recovery Act: Stimulus at the Extensive and Intensive Labor Margins," *European Economic Review* 85 (2016): 208–228.
 13. Congressional Budget Office (2012). "Estimated Impact of the American Recovery and Reinvestment Act on Employment and Economic Output from January 2012 Through March 2012." Accessed December 12, 2017 from: <https://www.cbo.gov/publication/43274>.
 14. Bill Dupor and M. Saif Mehkari, "The 2009 Recovery Act: Stimulus at the Extensive and Intensive Labor Margins," *European Economic Review* 85 (2016): 208–228.
 15. Bill Dupor, n.d. "Recovery.gov: Download Center User Guide," Accessed May 21, 2018 from http://billdupor.weebly.com/uploads/2/2/8/0/22808472/download_center_user_guide.pdf.
 16. Bill Dupor and M. Saif Mehkari, "The 2009 Recovery Act: Stimulus at the Extensive and Intensive Labor Margins," *European Economic Review* 85 (2016): 208–228.
 17. Bill Dupor and M. Saif Mehkari, "The 2009 Recovery Act: Stimulus at the Extensive and Intensive Labor Margins," *European Economic Review* 85 (2016): 226–227.
 18. RIMS II, IMPLAN, and REMI are each widely used modeling tools for economic impact analysis. Each is based on the input-output tables developed by the U.S. Department of Commerce. REMI is considered the most complex of the models as it incorporates econometric modeling techniques along with the basic input-output modeling.
 19. WSP, 2017, "2016 Economic Impact Analysis Technical Supporting Document," California High-Speed Rail Authority. Accessed May 21, 2018 from http://www.hsr.ca.gov/docs/brdmeetings/2017/brdmtg_071817_Item4_ATTACHMENT_Economic_Impact_Technical_Memorandum.pdf.

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21. WSP, 2017, "2016 Economic Impact Analysis Technical Supporting Document," California High-Speed Rail Authority. Accessed May 21, 2018 from http://www.hsr.ca.gov/docs/brdmeetings/2017/brdmtg_071817_Item4_ATTACHMENT_Economic_Impact_Technical_Memorandum.pdf, p. 12.
22. WSP, 2017, "2016 Economic Impact Analysis Technical Supporting Document," California High-Speed Rail Authority, Accessed May 21, 2018 from http://www.hsr.ca.gov/docs/brdmeetings/2017/brdmtg_071817_Item4_ATTACHMENT_Economic_Impact_Technical_Memorandum.pdf, p. 19.
23. For the Design Build construction contract, 40% has been spent as of July 2017; by July 2018 this figure is projected to rise to 68%, and by June 2019, fully 94% of the construction spending is projected to have occurred, with final spending taking place in December 2019.
24. Construction spending in FY16-17 was listed at \$987,794,356 according to the July 2017 TPEF report.
25. There were a few additional categories that were minor, including contingencies. These are excluded in Figure 6.
26. The FCP data is also potentially better suited for associating specific industries with spending given its greater level of detail, as discussed in Chapter IV.
27. For example, the July 2017 report is available at: https://www.hsr.ca.gov/docs/brdmeetings/2017/brdmtg_071817_FA_Contracts_Expenditures_Report.pdf.
28. Lynch explicitly compares RIMS II, IMPLAN, and REMI models and estimates.
29. An indirect employment effect from CP1 spending is employment that arises from suppliers of recipients of CP1 funds; an induced effect from CP1 spending is employment that arises from spending additional income that arises from CP1 spending, such as workers' spending on family needs.
30. Philip McCann, 2013, *Modern Urban and Regional Economics*, 2nd Edition, Oxford University Press, pp. 156–172.
31. Thijs ten Raa, 2005, *The Economics of Input-Output Analysis*, Cambridge University Press, pp. 178–181.
32. Craig H. Davis, 2001, *Regional Economic Impact Analysis and Project Evaluation*, UBC Press, pp. 9–11.

33. REMI, Inc., “REMI PI+ ver. 2.1 Model Equations,” retrieved from http://www.remi.com/wp-content/uploads/2017/10/Model-Equations-v2_1.pdf, December 20, 2017.
34. The REMI model is capable of projecting effects over a nearly fifty-year period, but, of course, the effects of spending farther and farther in the future diminish rapidly.
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