The Petroleum Industry and the Monterey Shale: Current Economic Impact and the Economic Future of the San Joaquin Valley

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EXECUTIVE SUMMARY

The petroleum industry has played a significant economic role in the San Joaquin Valley (SJV) for more than a century. Yet, both oil and gas production has steadily declined at the State and the SJV region levels since 1985 when production peaked. The Monterey Shale Formation (MSF) however, creates the opportunity of a new era for California and the SJV in terms of energy generation as oil and gas production could significantly increase again. The purpose of this report is twofold. First: to assess the current annual economic contribution of the petroleum industry in the SJV. Second: to assess the potential future economic impact of oil production from the MSF in the SJV. The forecasting methodology employed in this study makes use of historical data and relationships in order to make an educated guess about the likelihood of future events. However, predicting the future with the highest precision is not possible. Multiple unforeseeable events can change the historical relationships among variables and thus the forecast. Therefore, the results of the investigation should be taken with caution.

This report exclusively responds to the need to advance our understanding of the economic contribution of the petroleum industry in the SJV both current and future. As such, the study does not quantify the potential environmental and economic costs of oil and gas production associated with neither current levels nor future levels derived from the MSF. By the same token, this report does not take any position and does not make policy recommendations based on the findings. The findings, interpretations, and conclusions are the authors' own responsibility and do not necessarily represent any position of the University Business Center or California State University, Fresno.

The main findings can be summarized as follows:

- Oil reached a maximum production level in both California and in the SJV in 1985. Current levels of State and SJV oil production are less than half the production level reached in 1985.

- Oil produced by SJV counties currently represents over 75% of the total oil production in California while gas currently represents over 65% of the total gas production in California.

- With over 95% of the total oil and gas produced in the region, Kern is the largest producing county in the SJV and in the State as well. Kern's petroleum industry contributes almost 20% to the county's gross domestic product (GDP) and more than 5% to total employment.

- The petroleum industry along with the industries linked to it supports 52,271 jobs in the SJV (3.1% of total employment in the region), paying a total of $4.08 billion in annual labor income.

- The petroleum industry generates a total of $23.6 billion in sales for businesses located within the SJV, representing close to 10% of total sales in the region.

- In terms of the fiscal impact, the petroleum industry annually generates $364,991,480 in sales taxes and $386,058,743 in property taxes.

- The impact of the MSF oil production under the alternative scenarios in the SJV economy implies job gains between 2,151 and 34,485 under the high resource scenario; and between 2,151 and 195,683 under the high resource-oil boom scenario.

- Personal Income can grow by $201 million to $4 billion under the high resource scenario; and by $201 million to $22 billion under the high resource scenario-oil boom scenario.

- Taxable sales can grow by $74 million to $1.2 billion under the high resource scenario; and by $74 million to $6.7 billion under the high resource scenario-oil boom scenario.

- SJV's nominal GDP per capita can grow by $44 to $701 under the high resource scenario; and by $44 to $3,980 under the high resource scenario-oil boom scenario.

- At the county level, the job gains vary, being most substantial for Fresno and Kern Counties. For Fresno County the results suggest job gains between 519 and 8,327 under the high resource scenario; and between 519 and 47,251 under the high resource-oil boom scenario.

- Taxable sales are forecasted to grow for all counties in the SJV. However, just as in the case of employment, Fresno and Kern Counties taxable sales show the biggest gains. For Kern County the results suggest taxable sale gains between $20 million and $325 million under the high resource scenario; and between $20 million and $1.8 billion under the high resource-oil boom scenario

I. Introduction

The petroleum industry has played a significant economic role in the San Joaquin Valley (SJV) at least since 1899, with the discovery of oil in a shallow hand-dug oil well on the west bank of the Kern River.[1] Over a century later, the petroleum industry still represents a valuable source of high-paid jobs and income for SJV residents, profit for businesses, and tax revenue for state and local governments. Kern County alone currently produces more than 70% of the total amount of oil and more than 60% of the total amount of gas produced in California.[2]

On April 4, 2013 representatives of the Western States Petroleum Association (WSPA) approached the University Business Center (UBC) at California State University, Fresno about the need to conduct a study examining the current and potential future economic contribution of the petroleum industry to the SJV. An analysis of this nature seems particularly relevant in light of the Monterey Shale Formation (MSF), which is a 1,750 square mile band of subterranean shale rock formation that runs through the center of the State, mostly under SJV land. According to the U.S. Energy Information Administration, the MSF represents more than 15 billion barrels of oil,[3] which implies both a challenge and an opportunity to generate economic benefits for the SJV region.

While it remains unclear how many barrels of oil can actually be extracted in a profitable way (either using hydraulic fracturing techniques[4] or more conventional methods), as well as how changes in the regulatory framework for oil and gas extraction will shape up in California in the following months (mainly due to safety and environmental concerns), the interest of some oil companies in exploring this opportunity is growing as they keep bidding to lease mineral land for exploration.[5]

Furthermore, given the amount of attention and interest that hydraulic fracturing has recently generated due to the potential economic and non-economic implications of using this method to extract oil and gas from the MSF, it is worth mentioning that while it has evolved over

[1] For the purposes of this report, the San Joaquin Valley (SJV) is composed by Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus and Tulare counties.
[2] "2011 Annual Report of the State Oil & Gas Supervisor", State of California Department of Conservation (DOC).
[3] "Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays", U.S. Energy Information Administration (EIA), 2011.
[4] Hydraulic fracturing (also known as hydrofracturing, "fracking", or "fracing") is the high-pressure injection of a mix of fluids and chemical substances into an oil or gas reservoir. The mix, injected under pressure, fractures the reservoir rock. When the fluids are removed, the injected mix keeps open the cracks left by the fracturing, allowing oil or natural gas to flow back to the well.
[5] The Bakersfield office of the Bureau of Land Management (BLM), which manages 612,000 acres of public lands in eight Central California counties, auctions off mineral rights to public lands every quarter. The terms of the lease are relatively simple. Winning bidders have ten years to develop a working oil well on the land or the lease expires. They pay the BLM an annual rent of minimum $2 per acre, and the government receives 12.5 percent of revenues from the oil retrieved.

time, hydraulic fracturing is not a new extraction method.[6] According to the State of California Department of Conservation (DOC):

> "…*hydraulic fracturing was first used in 1947 in a well in Kansas. Since then, hydraulic fracturing has become a regular practice to tap into previously unrecoverable reserves, or to stimulate increased production from existing oil or gas wells in the United States. In California, hydraulic fracturing has been used as a production stimulation method for more than 30 years with no reported damage to the environment*."[7]

Also, although there are already requirements in place for all oil and gas wells drilled and constructed in California (including general laws and regulations regarding the protection of underground and surface water, and specific regulations regarding the integrity of the well casing, and others),[8] hydraulic fracturing has recently been under tougher scrutiny by both the public and California lawmakers. A variety of arguments have been advanced calling for stronger regulation and effective monitoring of hydraulic fracturing activities. Such arguments include water and air pollution, human-induced fault pressures in a State already prone to earthquakes, etc. However, the need for better understanding of the potential benefits and costs (both economic and non-economic) of hydraulic fracturing is evident. At the time this report was written the debate was still ongoing with no clear indication of how legislators will deal with the issue.[9]

This report exclusively responds to the need to advance our understanding of the economic contribution of the petroleum industry in the SJV both current and future. The study does not quantify the potential environmental and economic costs of oil and gas production associated with neither current levels nor future levels derived from the MSF. For example, this study does not attempt to quantify the potential reduction in agricultural land (if any) as the oil and gas production from the MSF expands. Also, the study does not address the potential quantity and price effects on water driven by the potential competition between the petroleum and agricultural industry as hydraulic fracturing activities expand. Similarly, the study does not examine the potential labor market implications such as potential increases in wage rates and reductions in the unemployment rate associated with increased economic activity due to extracting oil and gas from the MSF. Estimating these costs falls out of the scope of this study

[6] For a thorough discussion of oil and gas well drilling and well completion techniques, see "California's Oil, Gas, and Geothermal Resources, An Introduction," State of California Department of Conservation, 1993. Also, the Society of Petroleum Engineers produced a complete historical overview of hydraulic fracturing: http://www.spe.org/jpt/print/archives/2010/12/10Hydraulic.pdf

[7] http://www.conservation.ca.gov/dog/general_information/Pages/HydraulicFracturing.aspx

[8] See for example the California Public Resources Code sections 3106, 3203, 3211, 3220, 3222, 3224, 3255, and Title 14 of the California Code of Regulations, sections 1722.2, 1722.3, 1722.4, etc.

[9] The most recent event was the passing of SB 4 (amended on June 25, 2013), which includes a comprehensive hydraulic fracturing legislation authored by Senator Fran Pavley (D-Agoura Hills) that would essentially provide a framework for the permitting and disclosure of hydraulic fracturing in California and would require an independent scientific study on hydraulic fracturing addressing occupational, public and environmental health and safety to be conducted by January 1, 2015. See the California Legislative Information System: http://leginfo.legislature.ca.gov/

and thus it is a matter of a separate report.[10] By the same token, this report does not take any position and does not make policy recommendations based on the findings.

Therefore, the main purpose of the study is twofold. First: to assess the current annual economic contribution of the petroleum industry in the SJV. This segment of the analysis mostly addresses the number of jobs created/supported, income created, and tax revenue generated by current operations of the petroleum industry. Second: to assess the potential economic impact of oil production from the MSF in the SJV under alternative scenarios. This section of the study forecasts the per capita personal income, output per person, employment and tax revenue that could be generated within the next couple of decades if the MSF resources are tapped at various hypothetical production levels.

Finally, the forecasting methodology employed in the study makes use of historical data and relationships to make an educated guess about the likelihood of future events. However, no one can really predict future. Multiple unforeseeable events can change the historical relationships among variables and thus the forecast. This is particularly true when the data utilized involve variables that are inherently volatile such as inflation and oil prices. In addition, the uncertainty about the future policy environment as well as the yet to be determined productive capability of the advanced oil extraction technologies if applied to the MSF, significantly adds to difficulty in obtaining relatively accurate forecasts. Therefore, the results of the investigation should be taken with caution, especially at the county level, since they are the most sensitive to changes in the assumptions employed to derive them.

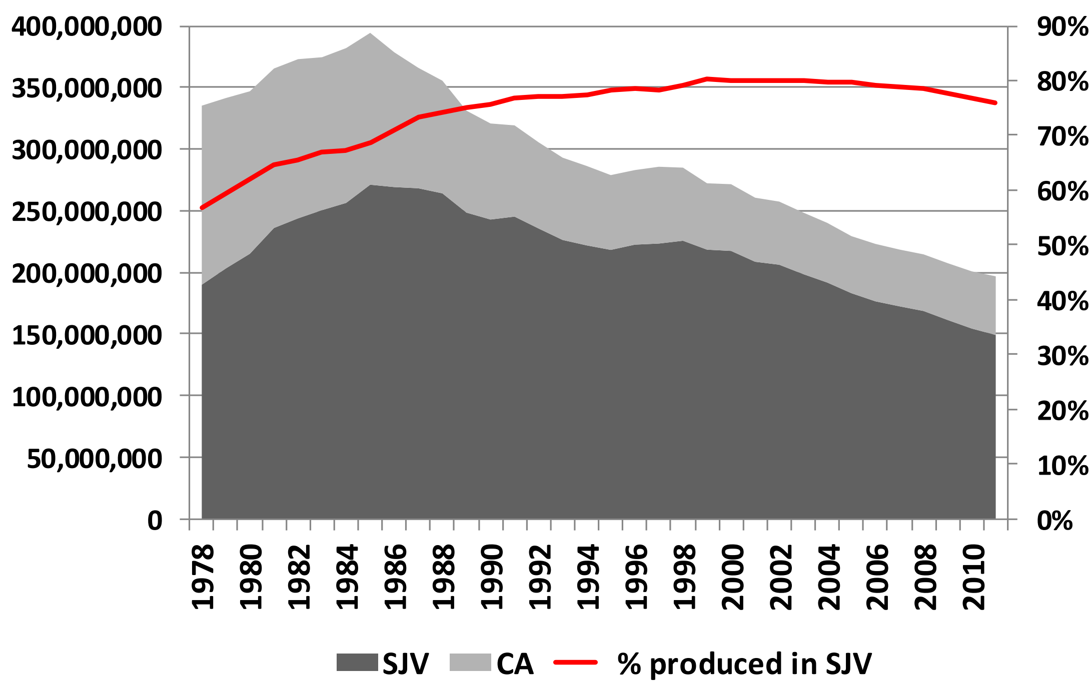
The findings, interpretations, and conclusions are the authors' own responsibility and do not necessarily represent any position of the University Business Center or California State University, Fresno.

[10] This report mostly encompasses an impact analysis which is different from a cost-benefit analysis in that it only estimates some of the benefits but it does not evaluate or quantify any of the costs.

II. Historical and Current Production of the Petroleum Industry in the SJV

In order to gain a relevant perspective for discussing the current and future potential economic contribution of the oil industry in the SJV, a brief overview of historical and current oil and gas production is appropriate. Figure 1 shows annual oil production in barrels (bbl) for California and for the SJV for the period 1978-2011.[11] The red line indicates the percentage of the State total oil production generated by SJV counties. The data reveal the following three salient facts. First, oil reached a maximum production level in both California and in the SJV in 1985.[12] Since the peak year, production has shown a steady decline. In fact, the current levels of state and SJV oil production are less than half the production level reached in 1985. Second, oil produced in the SJV as a percentage of the total oil produced at the State level reached a maximum more than 15 years later in 2002, when this proportion began to decline slowly. This indicates that oil production in the SJV has declined less rapidly than oil production at the State level. Third, oil produced by SJV counties currently represents over 75% of the total oil production in California as a whole, which unmistakably reveals the significance of the region for the petroleum industry.

Figure 1:
Oil Production (bbl) in California and the San Joaquin Valley (SJV): 1978-2011



SOURCE: "Annual Report of the State & Gas Supervisor", California Department of Conservation (DOC)

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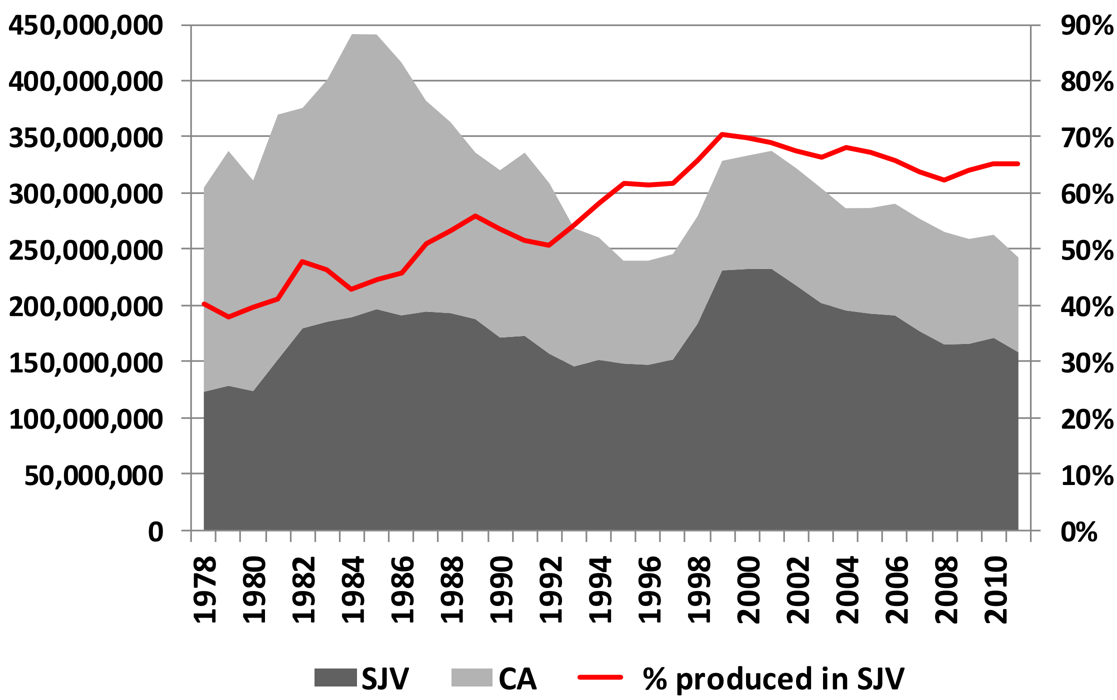
[11] The 2011 Annual Report of the State & Gas Supervisor by the California Department of Conservation (DOC) is the most recent report that contains oil and gas production figures at the county level.

[12] According to oil peak theory developed by American geophysicist King Hubbert, for any given geographical area the rate of petroleum production tends to follow a bell-shaped curve. Thus peak oil is the point in time when the maximum rate of petroleum extraction is reached, after which the rate of production is expected to enter terminal decline. The theory first appeared in "Nuclear Energy and the Fossil Fuels," which was Hubbert's 1956 presentation to the American Petroleum Institute during his tenure at the Shell Oil Company.

Figure 2 shows annual gas production in thousand cubic feet (McF) for California and for the SJV. The red line shows the percentage of the State total gas production generated by SJV counties. The data show the following three salient facts. First, gas reached a maximum production level in California in 1984. The same indicator for the SJV however, reached a maximum until 2001. The current level of State gas production is slightly more than half the production level reached in 1985, while the current level of SJV gas production is more than two thirds the production level reached in 2001. Second, gas production underwent a significant increase during the late 1990s. This production surge can possibly be explained by a substantial increase in gas prices during the same period,[13] but examining the factors that explain these changes falls outside the goals of this review. Third, gas produced by SJV counties currently represents over 65% of the total gas production in California as a whole, which again denotes the significance of the region for the petroleum industry. Finally it is worth noticing that, according to the California Department of Conservation, although at different degrees and possibly during different time periods, hydraulic fracturing has been used to extract oil and gas in the SJV for the entire period covered in this study (1978-2011).

Figure 2:
Gas Production (McF) in California and the San Joaquin Valley (SJV): 1978-2011



SOURCE: "Annual Report of the State & Gas Supervisor", California Department of Conservation (DOC)

[13] According to the California Energy Commission, the wholesale price of natural gas jumped from $2.61/Mcf in 1999 to $4.32/Mcf in 2000. See http://www.energyalmanac.ca.gov/

While the entire SJV is the region that produces the largest share of oil and gas at the State level, it is relevant to the discussion in the next sections of the report noting the significant differences in production levels that exist among SJV counties. Table 1 shows production of oil and gas by county for 2011, which is the most recent data reported at the county level contained in the Annual Report of the State & Gas Supervisor by the California Department of Conservation (DOC). With over 95% of the total oil and gas produced in the region, it is clear that Kern is the largest producing county not only in the SJV but in the State as well. Further, Kern County is the home of close to 80% of the total active wells in California. In contrast, notice that counties like Madera, Merced, San Joaquin and Stanislaus which produce some gas, produce no oil at all. The importance of highlighting these differences becomes more apparent in the next sections of the report since the economic contribution of the petroleum industry is relatively larger (smaller) in those countries where oil and gas production is higher (lower).

Table 1:
Current Oil and Gas Production in the San Joaquin Valley (SJV): 2011

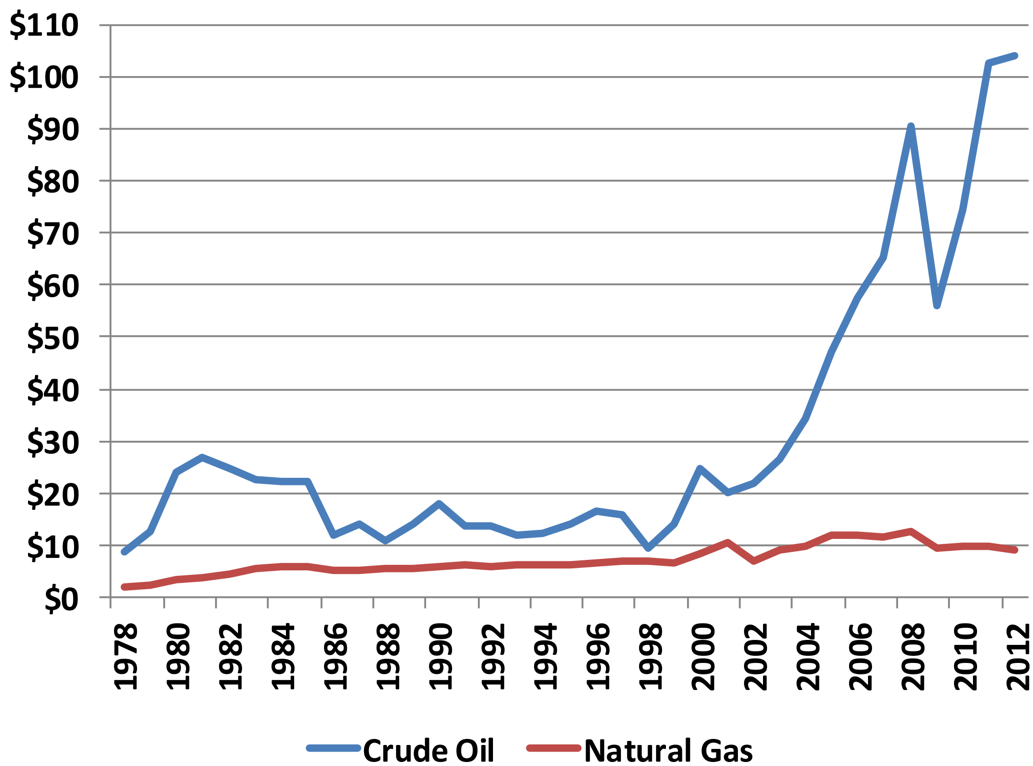
REGION	Number of Wells		Oil Production		Gas Production	
	ACTIVE	SHUT IN	(bbl)	% of State Total	(McF)	% of State Total
Fresno	1,963	1,554	6,048,407	3.07%	954,057	0.39%
Kern	42,159	15,691	142,991,052	72.67%	151,375,324	62.37%
Kings	160	176	110,026	0.06%	682,136	0.28%
Madera	12	19	0	0.00%	1,430,711	0.59%
Merced	1	2	0	0.00%	81,121	0.03%
San Joaquin	55	90	0	0.00%	3,209,005	1.32%
Stanislaus	2	0	0	0.00%	632,737	0.26%
Tulare	74	20	48,584	0.02%	0	0.00%
SJV	**44,426**	**17,552**	**149,198,069**	**75.82%**	**158,365,091**	**65.2%**
CALIFORNIA	**54,076**	**23,462**	**196,765,874**	**100.0%**	**242,708,524**	**100.0%**

SOURCE: "Annual Report of the State & Gas Supervisor", California Department of Conservation (DOC)

Finally, for completeness, a brief review of historical prices is appropriate. Figure 3 shows historical oil and gas nominal prices for the period 1978-2012. It is interesting to note the lack of a strong correlation between oil and gas production and their respective prices. During the last ten years, while the price of oil has shown a relative rapid and marked growing trend, production of oil has maintained its steady decline. However, the recent oil price surge combined with the technological advances in oil and gas extraction, are making hydraulic fracturing methods an increasingly attractive option to extract oil and gas, especially when considering the opportunity that exploiting the Monterey Shale Formation (MSF) is giving to petroleum companies with operations in California. It is also important to highlight that although both oil and gas production levels in the SJV are significant relative to the State's production levels, it is clear from the prices shown in Figure 3 that the revenue –defined as output multiplied by price-generated by oil production is larger than the one produced by gas. This observation is important since although the calculations in the next sections include both oil and gas, the economic impact and contribution of the petroleum industry is mostly due to oil.[14]

In sum, both oil and gas production show a clear declining trend at the State and the SJV region levels since the 1984-1985 when production peaked. However, the MSF creates the opportunity of a new era for California in terms of energy generation as oil and gas production could significantly increase again. This possibility, as well as its potential economic contribution to the SJV's economy, is explored later in the report.

Figure 3:
Historical Crude Oil and Natural Gas Nominal Prices: 1978-2012*



SOURCE: U.S. Energy Information Administration (EIA)

* California Crude Oil First Purchase Price (Dollars per Barrel) and California Price of Natural Gas Delivered to Residential Consumers (Dollars per Thousand Cubic Feet)

[14] The petroleum industry is more formally defined in the next section.

III. Current Annual Economic Contribution of the Petroleum Industry

III. 1 Scope and Methodology

The economic and fiscal contribution attributable to the petroleum industry is linked to two key factors: a) the annual production and operating expenses of the industry as well as the ways and places in which these resources are spent; and b) the ways and places in which the income received by petroleum industry employees is spent. Consequently, the economic and fiscal contribution is measured in four areas:

1) Output (business sales);
2) # of jobs that these expenses support directly and indirectly;
3) Labor income;
4) Local and state tax revenue.

This section of the study mainly relies on the use of input-output (IO) models and associated databases, which are techniques for quantifying interactions among firms, industries, and social institutions within a regional economy. IO models are the standard techniques that regional economists utilize to conduct economic impact analyses. In particular, the study makes extensive use of IMPLAN, which is a software that allows users to build economic models which estimate the impacts of economic changes in their states, counties, and communities. [15] The total economic impact (also known as the multiplier effect) of the petroleum industry is equal to the sum of three components: the direct effect, the indirect effect and the induced effect. Increases in economic activity resulting from the multiplier process become smaller as money circulates due to leakages from the spending stream. Spending on goods and services that are not produced within the regional economy do not generate additional local spending. Therefore, the multiplier process traces the flows of spending and re-spending until the initial expenditures have completely leaked out to other regions. To properly estimate the effects at the regional level, an adjustment known as the regional purchase coefficient is implemented within the IMPLAN system. The study employs the most recent IMPLAN data available to date, which corresponds to the year 2011.

For this report, the region of impact is the San Joaquin Valley (SJV) composed by Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus and Tulare Counties. The petroleum industry is defined as composed by the sectors and subsectors shown in Figure 4 which follows the North American Industry Classification System (NAICS).[16] Figure 4 also shows the corresponding IMPLAN sectors that are utilized in the analysis. The current annual

[15] A similar approach was utilized by the University of Texas in San Antonio in its 2013 study entitled "*Economic Impact of the Eagle Ford Shale*" and by the Pennsylvania College of Technology in its 2011 study entitled "*Economic Impacts of Marcellus Shale in Pennsylvania: Employment and Income in 2009*."

[16] This definition is similar to the one used by Purvin & Gertz in its 2011 study entitled "*Assessment of Petroleum Industry Economic Impact to the State of California*" commissioned by the Western States Petroleum Association (WSPS).

economic contribution estimates of the petroleum industry are estimated for each county in the SJV as well as for the SJV as a whole.

Figure 4: Definition of the Petroleum Industry

NAICS Code	IMPLAN Code	DESCRIPTION
211	20	Oil and Gas Extraction
213111	28	Drilling Oil and Gas Wells
213112	29	Support Activities, Oil/Gas Operations
32411	115	Petroleum Refineries
324191	118	All Other Petroleum and Coal Products
32511	120	Petrochemical Manufacturing
333132	206	Oil and Gas Field Machinery and Equipment
447	326	Gasoline Stations
486	337	Pipeline Transportation

SOURCE: IMPLAN

III. 2 Current Economic Size of the Petroleum Industry in the SJV[17]

Using the methodology described and based on the definition of the petroleum industry presented in Figure 4, the current economic size of the petroleum industry is shown in Table 2. The following three facts are worth highlighting. First, with $6,641,261,447 Kern's petroleum industry represents the highest value added in the SJV region with a contribution of near 20% to the county's gross domestic product (GDP). Also, the petroleum industry in Kern contributes to more than 5% of the total employment in the County, while workers in the petroleum industry receive the second highest average labor annual income per worker in the SJV region with $167,097. These indicators unmistakably reflect the importance of the petroleum industry in Kern County. Second, San Joaquin's petroleum industry represents the second highest value added in the SJV region with $314,477,023 as contribution to the County's GDP (1.4%), which is 20 times smaller than the contribution of the Kern's petroleum industry. These figures show the industry's economic value disparities among SJV counties which are evidently linked to the differences in oil and gas production levels as shown in Table 1. Third, the petroleum industry in the entire SJV directly employs 24,576 people, which represents 1.5% of total employment in the region, and adds $7,781,816,388 to the SJV's GDP, which represents a contribution of 5.6%.

[17] The figures in this section represent the direct contribution of the petroleum industry to the SJV's economy. The indirect and induced contributions are discussed in the next section.

Table 2:
Economic Size of the Petroleum Industry in the SJV: 2011

REGION	Value Added	Contribution to County's GDP	Employment	Contribution to County's Employment	Average Labor Income per Worker
Fresno	$253,984,043	0.7%	1,821	0.4%	$87,882
Kern	$6,641,261,447	19.3%	18,027	5.1%	$167,097
Kings	$42,046,156	0.8%	239	0.4%	$20,789
Madera	$87,526,975	2.0%	783	1.3%	$16,387
Merced	$89,632,348	1.3%	670	0.7%	$8,990
San Joaquin	$314,477,023	1.4%	1,402	0.5%	$181,980
Stanislaus	$102,752,063	0.6%	791	0.4%	$134,910
Tulare	$250,136,332	1.8%	844	0.4%	$27,761
SJV	**$7,781,816,388**	**---**	**24,576**	**---**	**$64,579**

SOURCE: Authors' calculations based on IMPLAN

III. 3 Current Economic Contribution of the Petroleum Industry in the SJV

Assessing the economic size of the petroleum industry, although meaningful by itself and revealing of the importance of the industry for the SJV region, provides only an incomplete picture of the full economic contribution of the petroleum industry. Since the petroleum industry is closely linked to other industries such as transportation, manufacturing, logistics, professional services, etc., the economic contribution of merely producing oil and gas is magnified as trucks are required to transport these commodities, as engineers and other technical professionals are employed to design and build wells and refineries, as advertising and communication specialists are hired to conduct market studies and launch marketing campaigns, etc. And all this happens as residents of the SJV work for all these related industries and consume food, clothes, services, etc. which in turn have an impact on the retail and whole industries as well. In other words, the multiplier effect that takes place as all these industries interact with each other within the SJV region implies that the full economic contribution of the petroleum industry is higher than just the economic value of producing oil and gas. Therefore, in order to accurately assess the current economic contribution of the petroleum industry, it is necessary to expand the analysis. This is achieved by hypothetically removing the petroleum industry from the regional economy and then looking at the impact of implementing this exercise on the other industries directly and indirectly linked. Essentially, the idea is to assume that the production of the petroleum industry (as defined in Figure 4) is reduced to zero and then examine the impact on the linked remaining industries. The total impact of this modeling technique (which captures the direct, indirect and induced impacts) represents the full economic contribution of the petroleum industry to the economy of the SJV. The results are shown Table 3. It is clear that the total contribution of the petroleum industry to the economy of the SJV is substantial. The petroleum industry along with the industries linked to it supports 52,271 jobs (3.1% of total employment in the region), paying a total of $4,081,286,864 ($4.08 billion) in labor income, which implies an average annual labor income of $78,079 per worker. In addition, the petroleum industry generates a total of $23,622,212,375 ($23.6 billion) in sales for businesses located within the SJV, representing close to 10% of total sales in the region.

Table 3:
Current Economic Contribution of the Petroleum Industry by County: 2011

	Employment	Labor Income	Business Sales (Output)	Sales Tax	Property Tax	Personal Income Tax
Fresno	3,247	$165,162,591	$588,829,650	$26,198,426	$27,710,596	$4,186,383
Kern	40,565	$3,254,080,677	$21,297,032,064	$272,619,264	$288,354,816	$78,377,184
Kings	347	$30,914,550	$62,054,158	$2,915,846	$3,084,148	$723,487
Madera	1,217	$52,374,958	$285,200,138	$12,980,351	$13,729,575	$1,232,189
Merced	975	$58,342,699	$151,862,275	$8,170,493	$8,642,093	$1,461,691
San Joaquin	2,868	$232,399,936	$714,874,812	$20,896,020	$22,102,134	$6,041,371
Stanislaus	1,246	$64,209,783	$135,431,312	$9,325,988	$9,864,283	$1,668,389
Tulare	1,806	$223,801,670	$386,927,966	$11,885,092	$12,571,098	$5,767,288
SJV	**52,271**	**$4,081,286,864**	**$23,622,212,375**	**$364,991,480**	**$386,058,743**	**$99,457,982**

NOTE: Labor income includes employee compensation and proprietor income
SOURCE: Authors' calculations based on IMPLAN

In terms of the fiscal impact, the industry generates $364,991,480 in sales taxes and $386,058,743 in property taxes. These two categories are relevant because in general, both sales and property taxes are levied and collected as tax revenue at the local (city or county) level. Also, the industry generates $99,457,982 in personal income tax that is collected at the State level. The data also reveal the predominant role of Kern County as the main contributor to the SJV's economy, which reflects its position as the largest producer of oil and gas in the State. Out of the total jobs supported in the SJV by the petroleum industry and the industries linked to it, 77% are located in Kern County earning an average annual labor income of $80,219 per worker, which is slightly higher than the average for the entire SJV. Similarly, city and county governments in Kern collect 75% of the total sales and property tax revenue generated in the region.

Finally, it is worth underlining that as discussed in the introduction section, the expectation that the economic contribution of the petroleum industry by county is proportional to oil and gas production is confirmed. In Merced County for example, which does not produce oil and only produces a relatively small amount of gas, the petroleum industry only makes a modest economic contribution. However, in order to understand how the petroleum industry can have an impact in a county where oil production is zero, it is essential to consider the regional nature of the SJV's economy. In other words, as explained in the methodology, the petroleum industry is more than simply producing oil and gas in a given location. Oil and gas must be transported to refineries, which in turn generate inputs for the manufacturing industry for the production of petroleum-based goods, which are then transported to the places of consumption through the retail and wholesale industries. All this simultaneously takes place with the assistance of multiple professional services such as engineering, accounting, marketing and legal. Obviously, the entire petroleum industry value chain takes place irrespective of county boundaries as transportation companies based in Merced County for example, are hired to move oil, gas, and gasoline across the State. Or as a marketing company based in San Joaquin County develops a business strategy for a gas station chain headquartered in Fresno County.

In sum, although some counties benefit more than others in economic terms, the inter-regional and inter-industry linkages that make up the entire petroleum industry value chain ensure that all SJV counties, its residents and its local governments collect some economic benefits.

IV. Potential Economic Impact of Oil Production from the MSF

IV.1 Scope, Methodology and Results Overview

The methodology is grounded on time series econometric techniques, which essentially produce forecasts based on historical relationships and data patterns. In particular, the study relies on dynamic linear models to forecast gross domestic product (GDP) per capita (output per capita), employment, income, and tax revenue for the SJV up to the year 2030. This methodology builds on the approach followed by the University of Southern California (USC) in its 2013 study entitled "The Monterey Shale & California's Economic Future." The fundamental idea is to compare the economic effects of simulated production patterns in the SJV region. Similar to the USC study, this report employs a baseline scenario as well as two alternative scenarios as described next.

The basic steps used to produce the forecasts are as follows:

(1) Determine the historical relation between real per capita income (as a proxy of real GDP per capita) in the SJV and the real value of oil output for the period 1978-2011.[18]
(2) Estimate three alternative scenarios of oil output for the MSF and determine the effect on the oil sector of the SJV in real terms for the years 2015, 2020, 2025 and 2030.
(3) Use the estimates from (1) and (2) to forecast the future value of real per capita income for the years 2015, 2020, 2025 and 2030. The idea is to compare the economic effect of simulated production patterns.
(4) Use the forecasted values of real per capita income and the historical relation of real per capita income with other relevant economic indicators, to forecast real GDP per capita, employment and tax revenue (taxable sales only) for the years 2015, 2020, 2025 and 2030.
(5) Estimate the potential future employment and taxable gains for each county in SJV, by applying the historical share of employment and taxable sales for each county in the SJV to the forecasted values of employment and taxable sales for the SJV.

In forecasting the effect of the MSF oil production in the SJV, a baseline scenario using the Energy Information Administration (EIA) reference scenario is estimated. In addition, two alternative scenarios are developed, a high resource scenario, based on the EIA tight oil forecast for the U.S., and a high-resource-oil boom scenario which uses as starting point the high resource forecast and assumes a growth rate of oil production similar to the one observed in North Dakota. Later in the paper, Section IV.3 describes in more detail the oil output scenarios. Table 4 below shows an overview of the main results. "Increment_A" refers to the difference between the high resource scenario and the baseline scenario. "Increment_B" refers to the difference between the high resource-oil boom scenario and the baseline scenario. The findings suggest that

[18] The complete label for the core variable is "*real per capita personal income*" as stated by the Bureau of Economic Analysis (BEA). For more details see Appendix A: Data, Definitions and Model. Within the text we use the shorter version: *real per capita income*. Also, per capita personal income is equal to personal income divided by population.

the MSF potentially can have a significant contribution to the economy of the SJV only if the rate of extraction is significantly higher than the baseline and high resource scenarios (both developed using EIA forecasts). Furthermore, under the high resource-oil boom scenario, the MSF oil production significantly reverses the downward trend of the SJV oil production shown in Figure 1.

Table 4:
Overview of the Results: SJV Region

	Year	Baseline	Increment_A	Increment_B
Per Capita GDP ($)	**2015**	31,898	44	44
total value of output in SJV	**2020**	34,368	190	949
divided by the population	**2025**	38,339	383	1,857
in the SJV	**2030**	42,455	701	3,980
Employment (jobs)	**2015**	1,568,187	2,151	2,151
total number jobs in the	**2020**	1,596,395	9,347	46,649
SJV	**2025**	1,612,998	18,807	133,335
	2030	1,617,777	34,485	195,683
Personal Income ($ millions)	**2015**	146,735	201	201
All income generated by	**2020**	170,935	946	4,719
all people in SJV	**2025**	205,011	2,046	14,502
	2030	243,332	4,020	22,813
Taxable Sales ($ thousands)	**2015**	53,939,260	73,974	73,974
revenue from tax sales	**2020**	54,909,496	321,496	1,604,524
in the SJV	**2025**	55,480,575	646,886	4,586,186
	2030	55,644,962	1,186,149	6,730,684

NOTE: Values of per capita GDP, personal income and taxable sales were converted from real terms into nominal terms. (The table in real terms is included in the Appendix B: Additional Tables). Values for personal income were estimated using our results of per capita personal income and population forecast for the SJV (San Joaquin Valley Demographic Forecasts, 2010 to 2050, The Planning Center, March 2012- prepared for Fresno Council of Governments)

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The impact of the MSF oil production under the alternative scenarios in the SJV economy between the years 2015 - 2030 is as follows (notice that all gains are in reference to the baseline):

- Job gains are between 2,151 and 34,485 under the high resource scenario; and between 2,151 and 195,683 under the high resource-oil boom scenario.
- Personal income grows between $201 million and $4 billion under the high resource scenario; and by between $201 million and $22.8 billion under the high resource-oil boom scenario.
- Taxable sales grow between $74 million and $1.2 billion under the high resource scenario; and between $74 million and $6.7 billion in the high resource-oil boom scenario.
- SJV GDP per capita grows between $44 and $701 in the high resource scenario; and between $44 and $3,980 under the high resource-oil boom scenario.

The next sections describe in more detail each of the steps followed to arrive to this forecast.

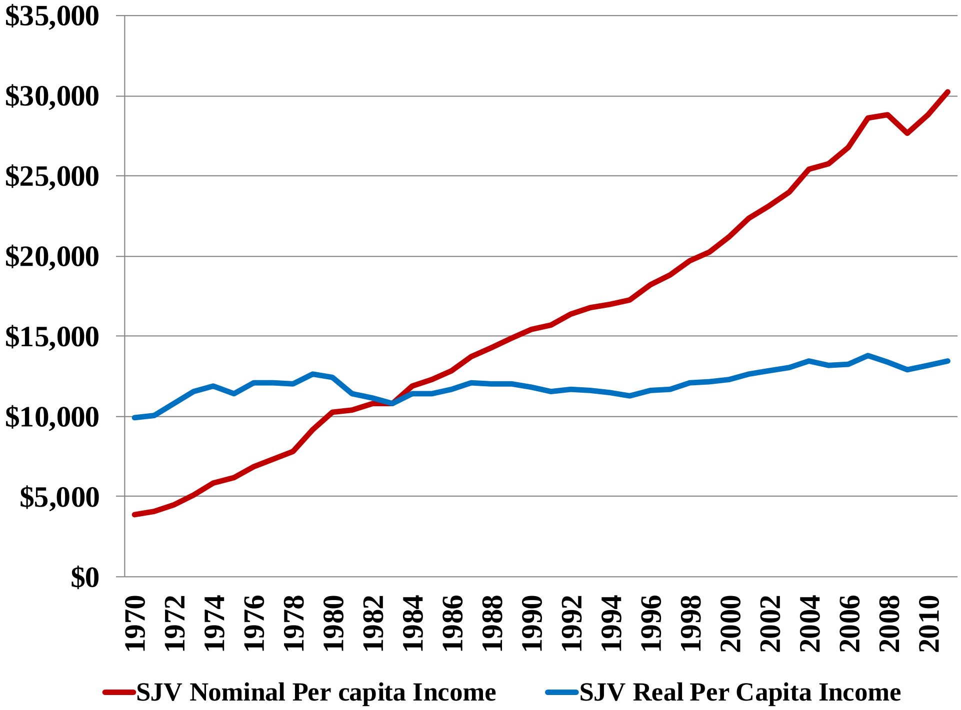
IV.2 Long-run Historical Relation between Real per Capita Income and Oil & Gas

As an initial step, a time series model is estimated to determine the historic long-term relation between real per capita income (as a proxy of real GDP per capita) and oil and gas output for the SJV.[19] The best fit is based on a dynamic linear model that considers past values of real per capita income as well as contemporaneous values of real oil and gas output. The results from this initial model allows to assess how the economy of the SJV has historically responded to changes in the oil and gas industry (e.g. how much output increases or decreases in the SJV when oil and gas output increases say by 1%).

Figure 5 shows the time series of average per capita income in real terms and nominal terms for all counties in the SJV. Notice that real per capita personal income in the SJV has fluctuated between $9,913 in 1970 and $13,825 in 2011, while nominal per capita income in the SJV presents a steeper upward trend, fluctuating between $3,846 and $30,281. For forecasting purposes real per capita income is used as an anchor to determine the value of all other relevant variables (employment, GDP per capita and tax revenue). The other component of the dynamic linear model is the real value of output for the oil and gas industry for the SJV. Figure 6 shows the real value of output of oil and gas in the SJV.

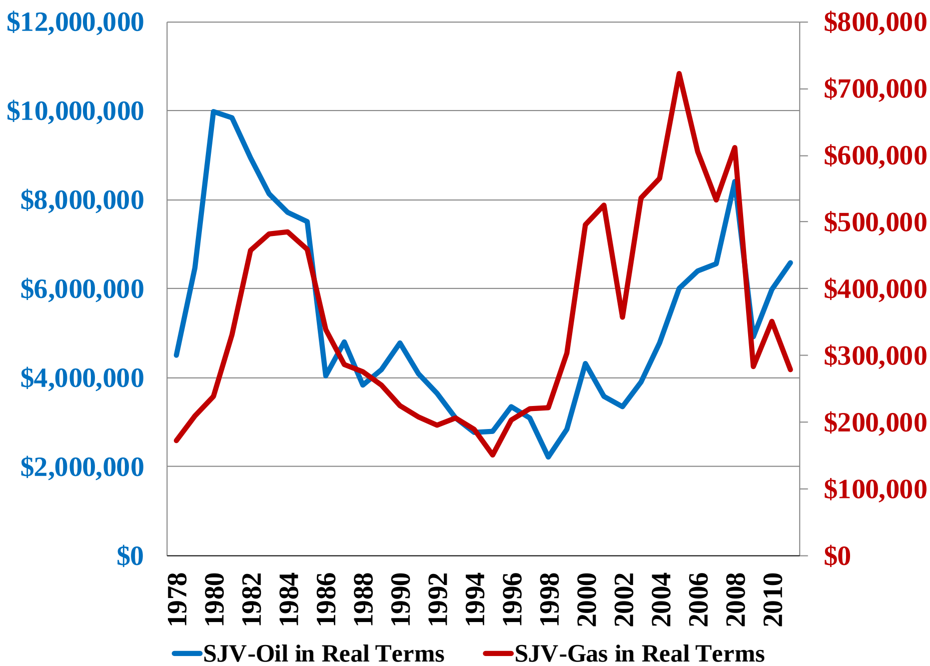
[19] Ideally, it would be better to estimate a model using Real GDP per capita. However GDP per capita is only available at the MSA level from 2001.

Figure 5:
SJV Real vs. Nominal per Capita Income



SOURCE: U.S. Bureau of Economic Analysis (BEA). CPI base 1984 was used to deflate nominal values.

Figure 6:
Real Value of Output of Oil and Gas in the SJV (in Thousand)



SOURCE: "Annual Report of the State & Gas Supervisor", California Department of Conservation.
NOTE: Nominal value of gas and oil production is deflated using CPI base (1982-1984). The detailed definition on how each variable was calculated can be found in the Appendix A: Data, Definitions and Model.

Using the time series for real per capita income and the real value of oil and gas production, the long-run historical relationship between these two variables per county and for the SJV is determined. A linear dynamic model in log-log form for both the oil and gas industry separately is estimated, and also for the oil plus the gas industry for the SJV and for each county. Since the dynamic linear model is in the log-log form, the estimated coefficient can be interpreted in terms of elasticity, that is, how much real per capita personal income increases/decreases when the value of real output of oil and gas increases by 1%. The results the dynamic model can be found in Table 5. [20]

Table 5:
Elasticity of Real per Capita Income to Changes in Oil and Gas Real Output

	Oil & Gas Output		Oil Output		Gas Output
Fresno County	2.52%	*	2.04%	*	0.06%
Kern County	2.22%	*	2.10%	*	0.62%
Kings County	1.07%		1.18%		0.01%
Madera County	0.54%		-		0.54%
San Joaquin County	0.58%		-		0.58%
Tulare County	1.06%		1.00%		-
San Joaquin Valley	2.37%	*	**2.31%**	*****	0.80%

NOTE: On average a 1% increase in the real value of the oil and gas output in the SJV will lead to a 2.37% increase in real per capita income in the SJV. Values for Merced and Stanislaus cannot be estimated due to very low or nonexistent production of oil and/or gas. "*" indicates statistically significant at the 5**%**

The results suggest that historically, real per capita income in SJV responds positively to changes in oil and gas real output. In line with the findings regarding the current contribution of the oil and gas industry, Fresno and Kern counties real per capita income are the most responsive to changes in oil and gas real output. When the effect of the oil and gas output are estimated separately, also consistent with our previous discussion, the results suggest that oil matters more than gas for the economy in the SJV. Therefore, for the forecasting scenarios the results from the effects of the oil production on the SJV are used. The main reason for relying on the results from oil production only (without including gas production) is that the forecast scenarios are based on alternative oil production assumptions from the MSF.

[20] As an alternative, ARIMA models for the SJV were also estimated, for each county and for both gas and oil and for gas and oil separately. However, the sample period is rather limited (1978-2011) for the ARIMA specification to provide reliable estimates.

IV.3 MSF Oil Output Scenarios and the Effects on the SJV Oil Industry

Baseline Scenario

Using as reference case scenario the U.S. Energy Information Administration (EIA) Annual Energy Outlook 2013 for California (2011-2040) and the historical ratio SJV oil output/CA oil output, it is estimated what the value of SJV oil output would be in 2015, 2020, 2025 and 2030. Also registered is the EIA Monterey tight oil production forecast. Table 6 shows the main oil output variables from the baseline scenario. In estimating the forecast of real per capita income, the SJV oil production in barrels of oil (line (3)) in real terms is utilized.

Table 6:
Baseline Scenario Forecast of CA, SJV and MSF Oil Production

Baseline scenario		2015	2020	2025	2030
(1)	California Oil Production (barrels per year)	174,341,520	165,090,960	165,309,960	155,558,255
(2)	California Oil Production (millions of barrels per day)	0.48	0.45	0.45	0.43
(3)	SJV Oil Production (barrels per year)	135,409,918	128,225,069	128,395,164	120,821,079
(4)	SJV Oil Production (millions of barrels per day)	0.37	0.35	0.35	0.33
(5)	MSF Tight Oil (millions of barrels per day)	0.025	0.035	0.040	0.05

SOURCE: (1), (3) and (4) Authors' calculations. (2) California oil production is from EIA "Annual Energy Outlook 2013". (5) Monterey tight Oil is from EIA tight oil forecast.

An important implication from this initial scenario is that oil production for both California and the SJV is expected to decline overtime. Under the baseline scenario the declining oil production in the SJV is not compensated by the additional oil from the MSF. This is consistent with the downward trend in oil production described in Section II of this report (see Figure 1).

High Resource Scenario

In order to estimate the SJV oil production under the high resource scenario shown in Table 7, the process is as follows:

(a) Find the value of SJV oil production net of MSF tight oil. Table 6 lines (4) minus (5) in the baseline scenario in barrels of oil.
(b) Find the ratio MSF tight oil from the baseline scenario to tight the oil forecast from the EIA baseline scenario. (See Appendix D: Tight Oil Alternative Scenarios, Figure 5).
(c) To find the MSF tight oil forecast in the high resource scenario, apply the ratio found in (b) to the tight oil forecast in the high resource scenario from the EIA.
(d) To find the value of SJV oil production in the high resource scenario, add the estimate of MSF tight oil (found in (c)) to the SJV oil production net of MSF tight oil (found in (a))
(e) To find California oil production in the high resource scenario apply the ratio CA oil production to SJV oil production (lines (1)/(3) from the baseline scenario) to the SJV oil production in the high resource scenario (found in (d))

Table 7:
High Resource Scenario Forecast of CA, SJV and MSF Oil Production

	High resource scenario	2015	2020	2025	2030
(1)	California Oil Production (barrels per year)	179,191,652	176,318,353	183,195,564	188,066,033
(2)	California Oil Production (millions of barrels per day)	0.49	0.48	0.50	0.52
(3)	SJV Oil Production (barrels per year)	139,176,984	136,945,311	142,286,796	146,069,658
(4)	SJV Oil Production (millions of barrels per day)	0.38	0.38	0.39	0.40
(5)	MSF Tight Oil (millions of barrels per day)	0.04	0.06	0.08	0.12

SOURCE: Authors' calculations. (5) MSF tight oil is estimated based on EIA "Annual Energy Outlook 2013" high resource scenario.

Different from the baseline scenario, under the high resource scenario, both California and the SJV oil production are expected to increase over time starting in 2020.

MSF High Resource-Oil boom Scenario

In order to estimate the SJV oil production under the MSF high resource-oil boom scenario (see Table 8), the process is as follows:

(a) Find the value of SJV oil production net of MSF tight oil. Table 7: lines (4) minus (5) in the baseline scenario in barrels of oil.
(b) Find the ratio MSF tight oil from the baseline scenario to tight the oil forecast from the EIA baseline scenario (See Appendix D: Tight oil alternative scenarios, Figure 5).
(c) To find the MSF oil production assume that MSF experience a growth rate similar to Bakken, ND starting in the year 2016, and apply that growth rate to the MSF tight oil high resource scenario (see (c) in high resource scenario).
(d) To find the value of SJV oil production in the high resource scenario, add the estimate of MSF tight oil (found in (c)) to the SJV oil production net of MSF tight oil (found in (a))
(e) To find California oil production in high resource scenario apply the ratio CA oil production to SJV oil production (lines (1)/(3) from the baseline scenario) to the SJV oil production in the high resource scenario (found in (d)).

Table 8:
High Resource-Oil boom Scenario Forecast of CA, SJV and MSF Oil production

Baseline scenario		2015	2020	2025	2030
(1)	California Oil Production (barrels per year)	179,191,652	281,765,535	339,580,309	333,050,057
(2)	California Oil Production (millions of barrels per day)	0.49	0.77	0.93	0.91
(3)	SJV Oil Production (barrels per year)	140,589,192	218,845,448	263,749,805	258,677,801
(4)	SJV Oil Production (millions of barrels per day)	0.39	0.60	0.72	0.71
(5)	MSF Tight Oil (millions of barrels per day)	0.04	0.11	0.34	0.40

SOURCE: Authors' calculations.

Notice that the increase in oil production for California and SJV is in fact substantial compared to the high resource scenario. Also notice that the contribution of the MSF to the SJV is the highest under the high resource-oil boom scenario (Table 6 line (5) versus Table 8 line (5)). That is, under this scenario the additional oil from the MSF reverses the downward trend in oil production in the SJV.

IV. 4 Forecast of Real per Capita Income under Alternative Scenarios

Using the estimated elasticity of the real per capita income in the SJV with respect to changes in SJV oil production found in section IV.1, the value of real per capita income is forecasted for the years 2015, 2020, 2025 and 2030 under alternative scenarios.[21] It is important to point out that the future MSF oil output from the three scenarios (baseline, high resource and high resource-oil boom) found in section IV.2 were converted into real terms, using the forecast oil price from the EIA and assuming a benchmark annual inflation of 2%.

An important caveat of this approach is that since it is based on historical data, the methodology cannot account for: (1) the possible structural changes that may occur in the SJV economy in the 27 year period (due for instance to migration of workers to the SJV or to changes in the regional industry mix for example); and (2) unexpected future oil shocks that may significantly increase the price of oil (due for instance to unexpected increases in the demand of oil or due to negative oil supply shocks).

Table 9 provides the forecast value of real personal income under the three oil output scenarios which we use as anchor to forecast the rest of the variables of interest.

Table 9:
Forecast Real Per Capita Personal Income under Alternative Scenarios

Real personal income ($)	2015	2020	2025	2030
Baseline scenario	13,917	14,167	14,315	14,357
High resource scenario	13,936	14,250	14,482	14,663
High resource-Oil boom scenario	13,936	14,581	15,498	16,094

SOURCE: Authors' calculations.

As shown in Table 9, real per capita income increases over time under all scenarios, albeit at a very low rate in the baseline scenario. The stagnant growth of real per capita income under the baseline scenario, from $14,315 in 2025 to $14,357 in 2030, is driven by the declining oil production in the SJV under this scenario (see Table 6). As expected, real personal income grows the fastest in the high resource-oil boom scenario.

[21] More accurately, the parameter estimates from the model in IV.2 are utilized to find the predicted values of the SJV real per capita income for 2015, 2020, 2025and 2030.

IV.5 Forecast of Real GDP per Capita, Employment and Real Taxable Sales

This section presents the forecast for the relevant economic variables (see Table 10) under the three scenarios. The forecast for each variable is obtained relying on the historical ratios between each variable and real per capita income and the forecasted values of real per capita income.

Table 10:
Forecast of Relevant Economic Variables

	2105	2020	2025	2030
Baseline Scenario				
SJV Real GDP per Capita	13,039	13,274	13,412	13,452
SJV Employment	1,568,187	1,596,395	1,612,998	1,617,777
SJV Real Taxable Sales	23,001,075	23,414,808	23,658,331	23,728,430
High Resource Scenario				
SJV Real GDP per Capita	13,057	13,409	14,171	14,775
SJV Employment	1,570,338	1,612,679	1,704,273	1,776,947
SJV Real Taxable Sales	23,032,619	23,653,651	24,997,085	26,063,014
High Resource-Oil Boom Scenario				
SJV Real GDP per Capita	13,057	13,662	14,520	15,079
SJV Employment	1,570,338	1,643,044	1,746,333	1,813,460
SJV Real Taxable Sales	23,032,619	24,099,019	25,613,998	26,598,565

SOURCE: Authors' calculations. SJV's employment is for the main MSA in each county in the valley. See Appendix A: Data, Definitions and Model.

IV.6 Potential Employment and Taxable Sales Gains by County

Using as a starting point the forecast for the SJV, estimates of the potential gains in both employment and sales taxes at the county level are obtained. In order to estimate the potential gains in employment at the county level, the historical contribution of each county to total employment in the SJV is utilized as well as the forecast value of employment in the SJV. Tables 11-A and 11-B show that all counties are expected to experience gains in employment under both scenarios.

Table 11-A:
Potential Job Gains by County

	Year	Baseline	Increment_A	Increment_B
		Fresno		
Employment (jobs)	**2015**	378,667	519	519
	2020	385,479	2,257	11,264
	2025	389,488	4,541	32,196
	2030	390,642	8,327	47,251
		Kern		
Employment (jobs)	**2015**	347,364	476	476
	2020	353,612	2,070	10,333
	2025	357,290	4,166	29,535
	2030	358,349	7,639	43,345
		Kings		
Employment (jobs)	**2015**	52,105	71	71
	2020	53,042	311	1,550
	2025	53,593	625	4,430
	2030	53,752	1,146	6,502
		Madera		
Employment (jobs)	**2015**	59,476	82	82
	2020	60,546	354	1,769
	2025	61,176	713	5,057
	2030	61,357	1,308	7,422

Table 11-B:
Potential Job Gains by County

	Year	Baseline	Increment_A	Increment_B
		Merced		
Employment (jobs)	**2015**	93,304	128	128
	2020	94,982	556	2,775
	2025	95,970	1,119	7,933
	2030	96,254	2,052	11,643
		San Joaquin		
Employment (jobs)	**2015**	255,676	351	351
	2020	260,275	1,524	7,606
	2025	262,982	3,066	21,739
	2030	263,761	5,622	31,904
		Stanislaus		
Employment (jobs)	**2015**	205,086	281	281
	2020	208,775	1,222	6,101
	2025	210,946	2,460	17,437
	2030	211,572	4,510	25,591
		Tulare		
Employment (jobs)	**2015**	176,509	242	242
	2020	179,684	1,052	5,251
	2025	181,553	2,117	15,008
	2030	182,091	3,882	22,025

An important caveat of this approach is that it assumes that the structure of the labor market within the valley will not change, which implies that is largest job gains will occur in Fresno and Kern counties.

In order to estimate the potential gains in taxable sales at the county level, the taxable sales contribution of each county to total taxable sales in the SJV in 2011 is utilized as well as the forecast of taxable sales in the SJV. Table 12-A and 12-B show that all counties are expected to experience gains in taxable sales under both scenarios.

Table 12-A:
Potential Taxable Sales Gains by County

	Year	Baseline	Increment_A	Increment_B
		Fresno		
Taxable Sales ($ thousands)	**2015**	12,049,201	16,525	16,525
	2020	12,265,937	71,817	358,426
	2025	12,393,507	144,504	1,024,483
	2030	12,430,229	264,967	1,503,531
		Kern		
Taxable Sales ($ thousands)	**2015**	14,811,787	20,313	20,313
	2020	15,078,216	88,283	440,604
	2025	15,235,034	177,636	1,259,372
	2030	15,280,175	325,718	1,848,254
		Kings		
Taxable Sales ($ thousands)	**2015**	1,427,044	1,957	1,957
	2020	1,452,713	8,506	42,450
	2025	1,467,822	17,114	121,334
	2030	1,472,171	31,381	178,070
		Madera		
Taxable Sales ($ thousands)	**2015**	1,381,593	1,895	1,895
	2020	1,406,445	8,235	41,098
	2025	1,421,072	16,569	117,470
	2030	1,425,283	30,382	172,399

Table 12-B:
Potential Taxable Sales Gains by County

		Merced		
Taxable Sales ($ thousands)	**2015**	2,559,432	3,510	3,510
	2020	2,605,470	15,255	76,135
	2025	2,632,568	30,695	217,616
	2030	2,640,368	56,283	319,373
		San Joaquin		
Taxable Sales ($ thousands)	**2015**	9,082,538	12,456	12,456
	2020	9,245,911	54,135	270,177
	2025	9,342,072	108,926	772,243
	2030	9,369,752	199,729	1,133,343
		Stanislaus		
Taxable Sales ($ thousands)	**2015**	7,180,782	9,848	9,848
	2020	7,309,947	42,800	213,606
	2025	7,385,973	86,118	610,546
	2030	7,407,857	157,909	896,037
		Tulare		
Taxable Sales ($ thousands)	**2015**	5,446,882	7,470	7,470
	2020	5,544,858	32,465	162,028
	2025	5,602,527	65,324	463,121
	2030	5,619,127	119,779	679,676

An important caveat of this approach is that it assumes that the structure of the economy within the valley will not change, which again implies that is largest taxable sales gains will occur in Kern and Fresno counties.

V. Concluding Remarks

As explained in the introduction and emphasized throughout the report, forecasting is not an exact science. Forecasting techniques rest on the use of historical data and relationships to make an educated guess about the likelihood of future event, but no one can really predict future. Numerous unexpected events can change the historical relationships among variables and thus the forecast, particularly when the data involves variables that are inherently volatile such as inflation and oil prices as is the case of this report. Therefore, the results of the investigation should be taken with caution, especially at the county level, since they are the most sensitive to changes in the assumptions employed to derive them. Furthermore, this report does not address the environmental implications of significant oil production from the MSF through the use of advanced oil extraction technologies such as hydraulic fracturing. It is expected that the current report will add to the ongoing discussion on natural resource exploitation in the SJV and should not be considered as an endorsement for additional oil production without first evaluating the potential environmental drawbacks.

It is evident that the total current contribution of the petroleum industry to the economy of the SJV is substantial: Along with the industries linked to it, the petroleum industry supports 3.1% of total employment in the region and generates a total of $23.6 billion in sales for businesses located within the SJV, representing close to 10% of total sales in the region. Also, the existence of the petroleum industry generates $364,991,480 in sales taxes and $386,058,743 in property taxes local governments in the SJV

From the summary table (Table 4 "Overview of the results"), it is also clear that, based on the forecasts presented, the MSF may only have a significant contribution to the economy of the SJV if its rate of extraction is significantly higher than under the baseline and high resource scenarios (based on EIA forecasts). Furthermore, only under the high resource –oil boom scenario MSF oil significantly reverse the downward trend of SJV oil production.

Appendix A: Data, Definitions and Model

Per capita personal income at the county level (1970-2011) – Source: BEA
Consumer Price Index (base 1982-84=100) – Source: BEA
Gas production at the county level (1978-2011) – Source: California Department of Conservation
Oil production at the county level (1978-2011) – Source: California Department of Conservation
Natural Gas Well-head price (1978-2011) – Source: EIA
Real Gas Production = (Gas production*U.S. Natural Gas Wellhead Price ($ per Thousand Cubic Feet)/CPI(Base 1984)
Real Oil Production = (Oil production WTI ($ per Barrel)/CPI(Base 1984)
Historical Oil prices-WTI (1978-2012) – Source: Federal Reserve Bank of St. Louis
Natural Gas forecast (2012-2040) – Source: EIA (Annual Energy Outlook 2013, reference case scenario EIA 2013)
Oil prices-WTI forecast (2012-2040) – Source: EIA (Annual Energy Outlook 2013, reference case scenario EIA 2013)
Employment at the county and MSA level (1990-2012) – Source: California Employment Development Department
GDP at the MSA level (2001-2011) – Source: BEA
Taxable Sales data at county level (2011) – Source: California State Board of Equalization.

The BEA definition of personal income is the income received by all persons from all sources. Personal income is the sum of net earnings by place of residence; dividends interest, and rental income (property income) of persons; and personal current transfer receipts. Net earnings is earnings by place of work (the sum of wage and salary disbursements (payrolls), supplements to wages and salaries, and proprietors" income) less contributions for government social insurance, plus an adjustment to convert earnings by place of work to a place-of- residence basis. Personal income is measured before the deduction of personal income taxes and other personal taxes and is reported in current dollars (no adjustment is made for price changes).

Models:

Dynamic model: Log-Log model Oil & Gas

Y-variable: log of real per capita personal income
X-variables: log of real per capita personal income-lagged, log of the real value of oil and gas output.

Dynamic model: Log-Log model Oil

Y-variable: log of real per capita personal income
X-variables: log of real per capita personal income-lagged, log of the real value of oil output.

Dynamic model: Log-Log model Gas

Y-variable: log of real per capita personal income
X-variables: log of real per capita personal income-lagged, log of the real value of gas output.

Appendix B: Additional Tables

Table 13:
Overview of the Results (in real terms)

	Year	Baseline	Increment_A	Increment_B
Real Per Capita GDP	**2015**	13,039	18	18
	2020	13,274	78	388
	2025	13,412	156	759
	2030	13,452	287	1,627
Employment (jobs)	**2015**	1,568,187	2,151	2,151
total number jobs in the	**2020**	1,596,395	9,347	46,649
SJV	**2025**	1,612,998	18,807	133,335
	2030	1,617,777	34,485	195,683
Real Personal Income	**2015**	59,982	82	82
	2020	66,020	387	1,929
	2025	71,716	836	5,928
	2030	77,097	1,643	9,326
Real Taxable Sales	**2015**	23,001,075	31,544	31,544
($ thousands)	**2020**	23,414,808	137,094	684,210
revenue from tax sales	**2025**	23,658,331	275,849	1,955,667
in the SJV	**2030**	23,728,430	505,804	2,870,135

SOURCE: Authors' calculations

Table 14:
County and Corresponding MSA

County	MSA
Fresno	Fresno
Kern	Bakersfield
Kings	Hanford-Corcoran
Madera	Madera
Merced	Merced
San Joaquin	Stockton
Stanislaus	Modesto
Tulare	Visalia

SOURCE: U.S. Bureau of Economic Analysis (BEA)

Appendix C: Assumptions for Forecasting Oil Output and Economic Scenarios

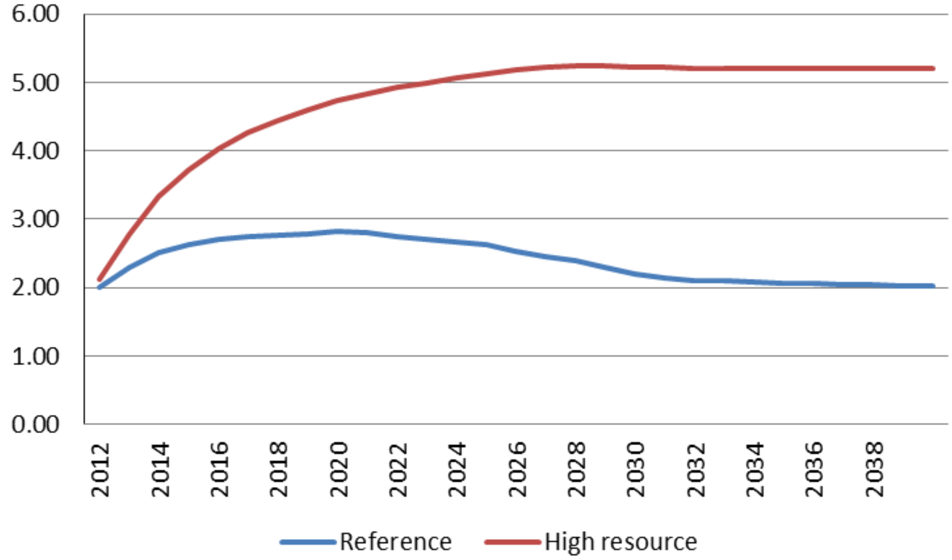
In the baseline scenario forecast, the reference case from the EIA for valuing oil and gas production in the valley is utilized, which assume 2.5% national economic growth. A couple of additional important assumptions are: 1) assume average future inflation of 2% per year (Federal Reserve historical reference) in all scenarios to deflate future nominal values; and 2) assume oil boom scenario (same growth rate as in Bakken, ND) in the MSF starting in 2016 using the high resource scenario tight oil forecast as starting point.

Important Caveat: The estimates of the potential of the Monterey shale in the SJV economy are sensitive to the baseline price that was used in valuing future production. Even if there is certainty on the value of output to be produced in the future, the uncertainty of the price component could significantly affect the estimates.

Appendix D: Tight Oil Alternative Scenarios

In order to estimate the MSF oil production for the baseline scenario and high resource scenario in section IV.2, two forecasts of tight oil from the EIA are employed.

Figure 7:
U.S Tight Oil forecast 2012-2040
(millions of barrels a day).



SOURCE: EIA, AEO2013 Early Release Overview.

The tight oil forecast estimated by the EIA "*represents resources in low-permeability reservoirs, including shale and chalk formations*"…and it includes "*Bakken/Three/Forks/Sanish, Eagle Ford, Woodford, Austin Clark, Spraberry, Niobrara, Avalon/Bone Springs and Monterey*". It is important to point out that as the EIA indicates "*estimates of technically recoverable resources from the rapidly developing tight oil formations are particularly uncertain and change over time as new information is gained through drilling, production, and technology experimentation…Technically recoverable resource estimates, however, embody many assumptions that might not prove to be true over the long term, over the entire range of tight or shale formations, or even within particular formations*."

Appendix E: Differences with the USC Report

This appendix briefly summarizes the main differences between this report and the USC report. The intent is to facilitate the understanding of the different forecast figures presented in both reports:

(1) The USC report focuses on the economic impact of the MSF oil production on the entire State of California while this report only deals with the SJV region. The difference in scope leads to major differences in data availability and thus in methodology.

(2) Given data availability at the state level, the USC report uses GDP per capita (net of oil and gas) at the state level as the main variable for the forecast exercise. This report uses real personal income per capita since GDP per capita is not available as a time series at the county level for a time period long enough to produce reliable forecasts.[22]

(3) The USC report relies on three models: (a) log-linear ARIMA model to estimate the effect of oil and gas production on net GDP per capita, for the period 1981-2010; (b) log-log ARIMA model to estimate the effect of oil production on GDP from oil and gas industry for the period 1981-2010; and (c) log-log ARIMA model to forecast GDP per capita in California. This report uses a log-log dynamic model to estimate the effect of real oil output on real per capita income for the period 1970-2011. Further, there is no available data for GDP from the oil and gas industry at the county level.

(4) The USC report develops two enhanced drilling scenarios: (a) a low "Adapted EIA advanced technology oil drilling scenario" and (b) a high "projected advanced-technology oil well drilling scenario". For scenario (a) the USC report uses as starting point the EIA Annual Energy Outlook **2012** and applies the projected U.S. unconventional to conventional production ratio to California conventional oil production to estimate California unconventional technology oil production in forecast years (MSF oil production). For scenario (b) the USC reports relies on in-house estimates (USC School of Engineering). In contrast, this report relies on the EIA Annual Energy Outlook **2013**, as starting point for all three scenarios: baseline, high resource and oil-boom high resource. For the baseline scenario the numbers for California are taken from the EIA Annual Energy Outlook 2013, and the oil production from SJV is calculated using the historical ratio California oil production to SJV oil production. The high resource scenario uses the U.S. Tight Oil forecast 2012-2040 from the AEO2013 Early Release Overview. The high-resource oil boom, assumes that the MSF experience a growth rate similar to Bakken, ND starting in the year 2016 on, and apply that growth rate to the high resource scenario.

In order to illustrate the differences between the USC report and this report the oil production from high "projected advanced technology oil drilling scenario" from the USC is used as input to the main model in this report. The results of this exercise are presented in Table 16 below.

[22] Real GDP and nominal GDP at the MSA are only available starting in 2001.

Table 15:
Overview of the Results when Using USC
High "*projected advanced technology oil drilling scenario*"

	Year	Baseline	Increment_C
Real Per Capita GDP	**2015**	13,039	44
	2020	13,274	3,053
	2025	13,412	5,847
	2030	13,452	6,474
Employment (jobs)	**2015**	1,568,187	2,151
total number jobs in the	**2020**	1,596,395	150,070
SJV	**2025**	1,612,998	287,435
	2030	1,617,777	318,262
Real Personal Income	**2015**	59,982	201
	2020	66,020	15,182
	2025	71,716	31,263
	2030	77,097	37,104
Real Taxable Sales	**2015**	23,001,075	73,974
($ thousands)	**2020**	23,414,808	5,161,804
revenue from tax sales	**2025**	23,658,331	9,886,591
in the SJV	**2030**	23,728,430	10,946,919

The last column of the Table, labeled "Increment_C", shows the potential gains assuming the high "projected advanced-technology oil well drilling scenario" for the MSF from the USC report. For comparison purposes Table 16 is equivalent to Table 5

About the University Business Center (UBC)

The University Business Center (UBC) serves as the outreach arm for the Craig School of Business at Fresno State by offering professional development programs and state-of-the-art meeting facilities. The UBC focuses on providing business and professionals with services and resources to foster growth, create jobs and develop a prosperous economy. The UBC's present facilities were built in 1987 with donations from private businesses. The UBC has an impressive history of serving private enterprises and public organizations throughout California's Central Valley.

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