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# Job growth and loss across sectors and time in the western US: The impact of large wildfires $\stackrel{\leftrightarrow}{\sim}$



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Forest Policy

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#### ABSTRACT

The link between economic growth and natural hazards has long been studied to better understand the effects of natural hazards on local, regional, and country level growth patterns. However, relatively little generalizable research has focused on wildfires, one of the most common forest disturbances in the western United States (US). We examined the effect of large wildfires on employment growth across sectors and time in the western US. We matched wildfire occurrences from 2004 to 2008 and their duration with monthly employment data to identify the effect of wildfire on employment growth. Wildfires generally tended to exhibit positive effects on employment during the periods that suppression efforts were active. However, the overall positive effect masks winners and losers across sectors — such as natural resources and mining and leisure and hospitality, respectively. The overall positive effect then transitioned to a negative drag on local employment growth for a period of up to two years following the wildfire. We explore reasons why some sectors win while others lose and explanations for the lingering effects of a large wildfire on the economy as a whole.

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#### 1. Introduction

On June 20, 2008, thunderstorms swept across northern California sparking hundreds of wildfires. In Trinity County, the ignitions eventually formed into 13 wildfire complexes. Firefighters spent the rest of the summer, into October, trying to suppress and manage the fires. The United States (US) government alone spent over \$150 million on the suppression effort. Although the summer of 2008 in Trinity County has been colloquially referred to as the "lost summer" (Davis et al., 2011), the economic impacts on the local community varied – recreation businesses uniformly reported losses whereas natural resource businesses reported a mix of gains from participating in the suppression effort to losses from having to delay or cancel forest-based projects. The Hayman Fire in Colorado in 2002 tells a similar story (Kent et al., 2003). Butry et al. (2001) find that the 1998 wildfires in northeastern Florida had economic impacts of similar scale to a Category-2 hurricane. These studies and others that have looked at economic impacts from natural hazards such as hurricanes, tornados, and earthquakes suggest that the effects of natural disasters will vary across economic sectors and time (Rose and Lim, 2002; Belasen and Polachek, 2009; Ewing

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et al., 2009). Wildfires may result in economic winners and losers across industries or time as employment levels adjust upwards to meet the needs of fire suppression and recovery efforts or adjust downwards due to disruptions in normal economic activity.

Understanding the impact of wildfire on local economies is important given that wildfire is one of the most costly and significant disturbances in forests of the western US (Holmes et al., 2008a). The 11 contiguous western US states are home to more than 225 million acres of forests. Over two-thirds of western forests are publically managed. primarily by the US Forest Service (Smith et al., 2001). The average annual US government expenditure on wildfire suppression between 2000 and 2009 was over \$1.5 billion per year (in 2009 dollars; Gebert and Black, 2012), most of which was spent on wildfires occurring in the western US. Like in many parts of the world (Flannigan et al., 2009), wildfire activity in the western US is increasing with greater frequency and duration of large wildfires and a longer fire season (Westerling et al., 2006). Although there are many local, regional, and national efforts in policy, collaboration, and forest management to reduce the occurrence and significance of large wildfires, the combination of past fire suppression, climate change, and expansion of the wildland-urban interface (Running, 2006; Gude et al., 2008) ensures that wildfire suppression and management will continue to be an important natural resource, economic, and policy issue for the foreseeable future.

Most investigations into the economic impacts of natural hazards have taken a case study approach — an in-depth inquiry into a specific wildfire (e.g., Butry et al., 2001, Kent et al., 2003), hurricane (Garber et

 $<sup>\</sup>stackrel{\text{fr}}{\longrightarrow}$  Note: Work on this paper was primarily conducted while the lead author was a member of the research faculty at the University of Oregon's Institute for a Sustainable Environment.

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al., 2006), tornado (Ewing et al., 2003, 2009), earthquake (Rose and Lim, 2002), or flood (Xiao, 2011). Other studies have analyzed the economic trajectories of countries with respect to the level of risk and frequency of natural hazards (Tol and Leek, 1999; Skidmore and Toya, 2002), showing that, in the long run, natural hazards can result in investments in human capital, economic adaptation, and overall productivity gains. A generalizable approach that isolates the sectoral or temporal effects of a natural disaster on a local economy is rare (e.g., Belasen and Polachek, 2008, 2009). Nielsen-Pincus et al. (in press) showed that wildfires generally create a net increase in local employment and wages during a fire, but that seasonal patterns of employment and wages become amplified for a period of time following a wildfire. High season labor demand gets higher and the low season demand gets lower. Aggregate changes in the labor market and seasonal patterns are important measures of local economic response; however, these measures may mask larger and differential sectoral effects from wildfire and more fundamental non-seasonal trends over time. Our objective is to fill this gap in the literature by reporting a sectoral and temporal analysis of employment growth with respect to large wildfires in the western US.

We examine the effect of large wildfires on local labor markets using a panel study approach that asks two main questions:

- 1. How does the effect of large wildfires on local employment growth vary by economic sector?
- 2. How does local employment growth trend change over time following the occurrence of a large wildfire?

We used US federal agency data on wildfire and county-level employment growth to isolate the effects of large wildfires on local employment growth by sector in a panel regression framework. We deseasonalized the labor market data and controlled for temporal trends in employment growth as well as state business cycles to isolate the effect of wildfires on employment growth by sector and over time following a wildfire. Finally, we discuss the economic implications of wildfire and conclude with several important policy considerations for national wildfire management policy.

#### 2. Methods

We use a generalized difference-in-difference modeling approach (see Belasen and Polachek, 2008, 2009) to estimate the effect of large wildfires on local labor markets. The approach compares the impact of a set of exogenous economic shocks (large wildfires in our case) occurring in particular counties to a set of counties that did not experience the exogenous shock. As such, the approach sets up a quasiexperiment with a treatment/control group comparison. Specifically, we examine the effect of wildfires that occurred during the five-year period between 2004 and 2008 on employment growth during periods when active wildfire suppression was occurring. We disaggregate employment growth into high-level economic sectors to examine how the effects of wildfire vary by industry, and we examine the 24-month period following the end of suppression activities to identify whether local economies undergo a period of employment adjustment following large wildfires. We next describe the panel structure of the wildfire and employment data.

#### 2.1. Data

We constructed our panel dataset from two primary sources: (1) we collected employment data from the US Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW), and (2) we collected fire occurrence data from the US Forest Service (FS). QCEW data included county-specific monthly employment levels by economic sector for the 11 western states (AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY) from 2003 to 2008 and is the basis for our dependent variables. We seasonally adjusted the employment data using a 12 month ratio-

to-moving-average method (Harvey, 1994) for each economic sector in each county and state using Eq. (1).

$$\Delta N = \frac{(N_t - N_{t-12})}{N_{t-12}}$$
(1)

where *N* represents employment in the relevant sector and geography and the year-over-year calculation removes seasonality. We examined 10 economic sectors: natural resources and mining; construction; manufacturing; trade, transportation, and utilities; information services; financial activities; professional and business services; education and health services; leisure and hospitality services; and the federal government. We calculated employment growth for each of these ten sectors by state and by county.

We obtained wildfire occurrence data for 2004 to 2008 for all wildfires for which the US Forest Service was the lead suppression agency and for which the suppression effort cost the Forest Service more than \$1.0 million. Fire occurrence data was obtained from the National Interagency Fire Management Integrated Database, which contains attributes about each incident including the ignition location (Latitude/ Longitude), the initial attack date, and the date on which the suppression objectives were met. We assigned each wildfire to the county in which the ignition location occurred and used the suppression dates to identify the set of months for which large wildfire incidents were being actively suppressed. We then summarized the wildfire occurrence data by county and month and joined it with the employment growth data. The panel structure of the data is organized such that each of the 413 counties in the 11 contiguous western US states includes observations for employment growth for the county in aggregate and by sector, employment growth for each county's respective state in aggregate and by sector, and a dummy variable indicating whether a large wildfire was being actively suppressed or not during each time period. The year-over-year ratio for calculating monthly employment growth results in dropping the first year of observations because they have no previous year's observations on which to calculate growth. Therefore temporal observations for growth span 2004 to 2008, matching the time period for which wildfire incident data was obtained and resulting in a total of 60 temporal observations for each county in total and for each county by sector.

#### 2.2. The sectoral and temporal employment growth models

We specified the sectoral employment growth model in SAS 9.3 using the Da Silva panel procedure method, which partitions variance in the dependent variable into components attributed to the explanatory variables (e.g., wildfire), cross-section, time period, and otherwise unaccounted for residual variance.<sup>1</sup> We used a moving average error term that accounted for the fact that, although the employment growth rate calculation does remove seasonality in the data, it does not ensure stationarity across the time series. The functional form of the model is expressed as

$$\Delta N_{it} = \mathbf{x}_{it}\beta + a_i + b_t + e_{it} \tag{2}$$

where  $\mathbf{x}_{it}$  is a vector of p explanatory variables,  $a_i$  is a time-invariant cross sectional effect,  $b_t$  is a cross-sectionally invariant time effect, and  $e_{it}$  is a residual term that is specified as a moving average error structure

<sup>&</sup>lt;sup>1</sup> Some authors have tested for the effects of natural disasters in neighboring counties on local employment and wages. Belasen and Polachek (2008) tested for the effect of hurricanes on counties adjacent to those that were directly hit by the hurricane and found effects that differed from the effects in the directly hit counties. Nielsen-Pincus et al. (2012) tested for the effect of wildfire in an adjacent county on local employment and wages, and found an effect on average wage growth that was similar to the directly hit county, but no effect on employment growth. Further, Nielsen-Pincus et al. (in press) found that the effect of federal wildfire suppression spending in adjacent counties on local employment was less than 0.1%. Based on these wildfire-specific findings, we did not specify the model to account for spatial autocorrelation or any other spatial effects on employment.

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