To: Governor Gavin Newsom
From: Alex Zhou
Date: May 5, 2021
Re: Impact of COVID-19 on Health, Spending, and Employment in California

California's COVID-19 strategy is unique for its stringency: with one of the earliest lockdown dates as well as a late business reopening date compared to the rest of the nation, the state has prioritized public health throughout the pandemic. In this report, I examine the impacts of California's COVID-19 response on the state's trends in health, spending, and employment, as well as the potential trade-offs between these variables in policymaking.

I first examined trends in COVID case rates, consumer spending, and employment changes in California since the pandemic. Notably, California saw a significantly lower daily case rate in April 2021 than the U.S. average, and it also had the lowest case rate by far out of its surrounding states. California exhibits similar trends in spending to neighboring states and to the U.S. overall, characterized by a massive drop in spending at the beginning of the pandemic, followed by a continuous period of steady regrowth. As of April 2021, California's level of spending has recovered to about the same level of pre-pandemic spending. Employment, on the other hand, seems to have taken a larger hit in California than both health and spending. Following the initial drop at the beginning of the pandemic, employment has slowly trended upward, but in April 2021 employment in California was still 3.6% lower than pre-pandemic employment. Nevada and Arizona, for contrast, saw April 2021 employment that was 0.2% higher and 2.6% higher than early 2020 levels, respectively. Based on these trends, COVID-19 appears to have had more detrimental effects on employment than on either spending or health in California.

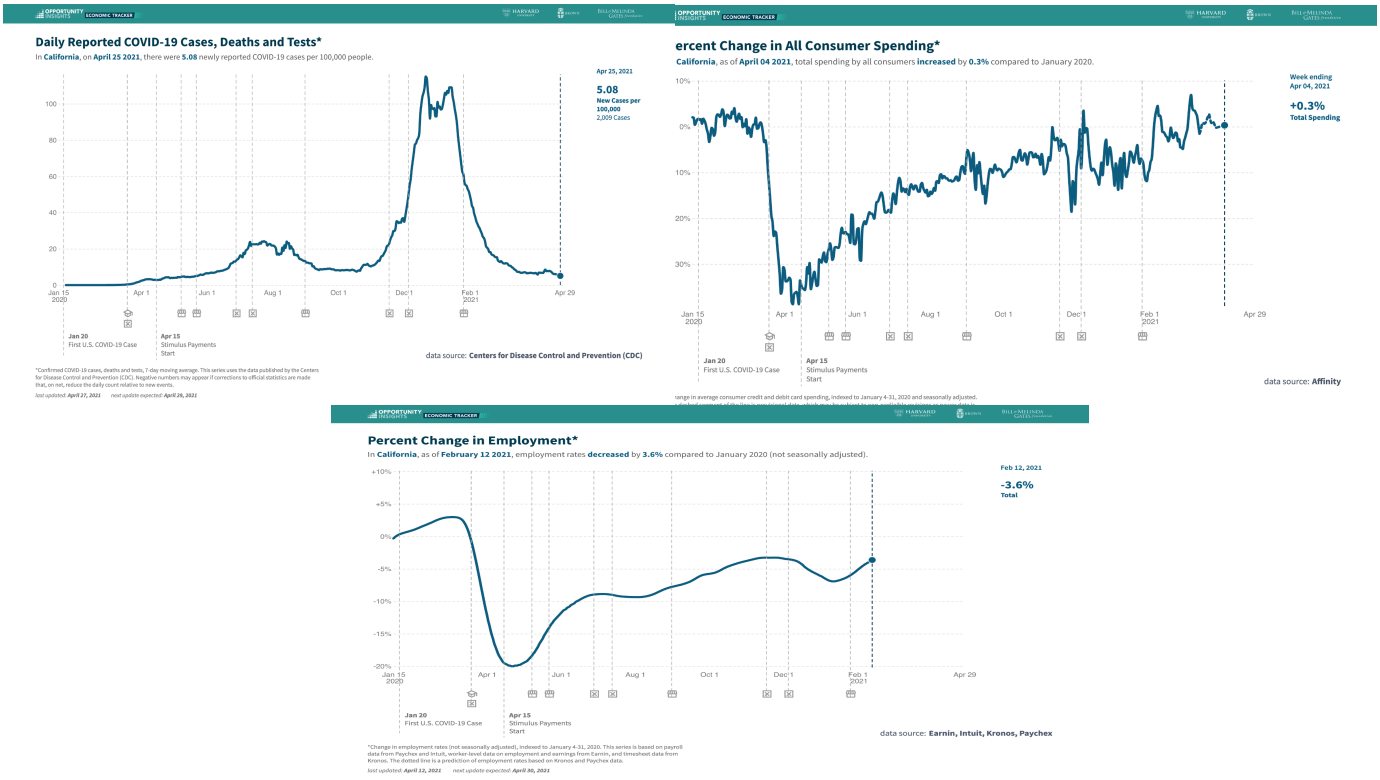

Figure 1. California COVID-19 case rate, consumer spending, and employment trends.

These graphs represent state-wide trends, but conditions that affect public health, spending, employment, and pandemic progression can vary widely across groups in California. Therefore, I decided to examine which counties have been disproportionately affected by the pandemic, both initially and long run. One interesting discovery was that health impacts have varied widely by a region's overall education level. In particular, counties with higher shares of college-educated residents tended to have higher COVID-19 case rates than counties with fewer college-educated residents at the beginning of the pandemic. However, the reverse becomes true when looking at long-run outcomes. Counties with higher proportions of educated residents actually tended to have lower case rates in 2021 than counties with lower educated shares, despite being harder-hit earlier in the pandemic.

I also uncovered differences in spending changes between low-rent and high-rent areas. Both at the pandemic's onset and in early 2021, higher-rent regions tended to have higher drops in spending. The strongly negative association between rent and spending was another surprise, as I would have expected counties with higher average rent to be more affluent overall and therefore have lower drops in spending compared to counties with lower average rent.

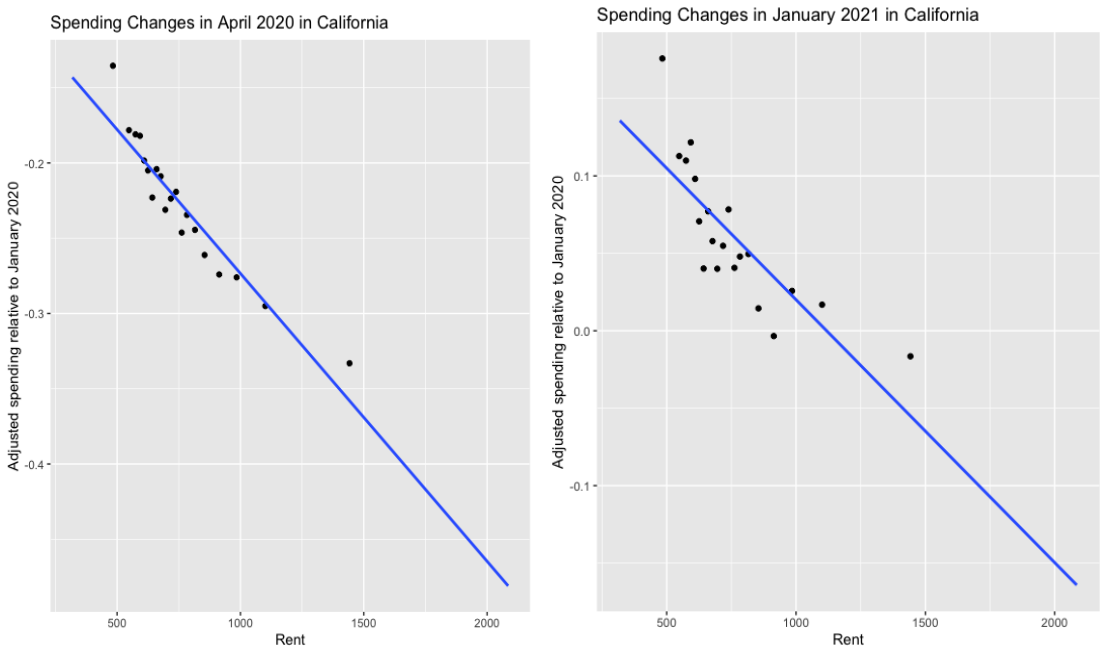

Figure 2. Association between average rent and short-term (left) and long-term (right) spending.

The relationships between poverty rates and employment changes across counties also presented a shocking result. I initially would have hypothesized that COVID-19 would impact employment more negatively in high-poverty areas than in areas with low poverty. However, the data indicates an opposite effect. Areas with lower poverty rates actually saw greater losses in employment both during the initial effects of COVID as well as after a year of recovery.

Given the national trend of low-wage employment taking harder hits than overall employment, I also investigated whether or not the positive relationship between poverty rate and employment recovery would hold when looking only at low-wage employment. Although there is slightly less

data for low-wage employment changes, descriptive statistical analysis confirms that this association also applies to low-wage employment, not just overall employment.

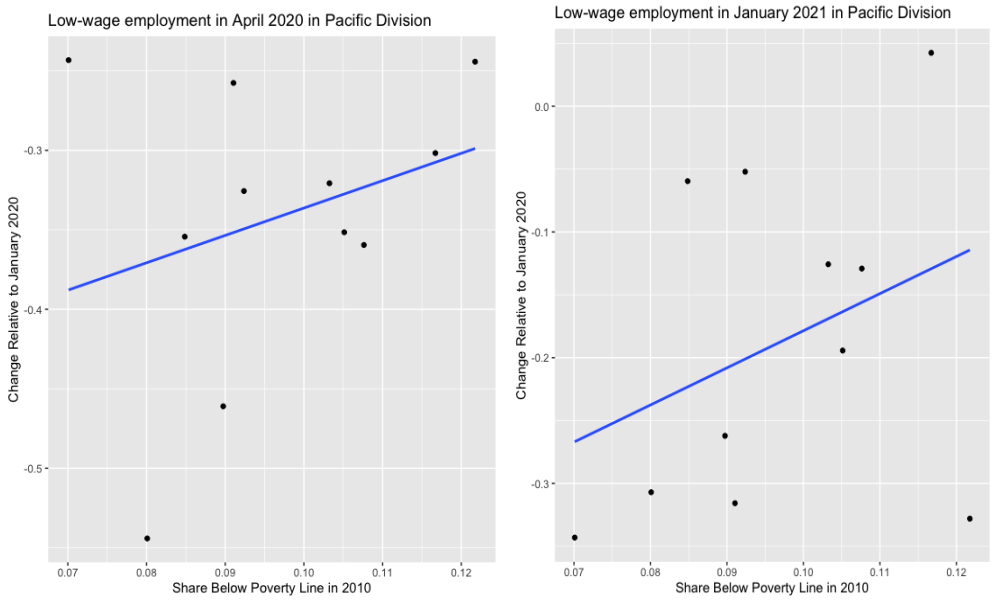

Figure 3. Relationship between poverty and low-wage employment.
(Due to a lack of data for California, I plot Pacific Census Division data instead.)

Thus far in my analysis, I have only explored trends and associations in data rather than causal links. Take, for example, the relationship between rent and spending displayed in Figure 2. Though counties with higher average rent tend to have lower spending post-pandemic, it is important to recognize that this does not give any evidence that rent directly affects spending. It is entirely possible that the observed relationship between any two variables is simply due to differences in another confounding variable, so I refrain from drawing any causal inferences at this point. Another limitation of my analysis is the lack of employment and low-wage employment data in California. As a workaround, I analyzed trends in the entire Pacific Census Division instead, but this census division includes data from several other states which could lead to flawed conclusions on which groups in California actually saw disproportionately

impacts in employment. Nevertheless, for analysis purposes, I assume that the census division data is roughly representative of similar trends in California.

My descriptive analysis so far only reveals correlations, not causations, between variables, but I wanted to explore the causal effects of California's early stay-at-home and late reopening policies on outcomes. Given that these policies apply uniformly across the population, I expect that changes in health, spending, and employment would be consistent across all groups if these statewide orders had not come into effect. This assumption of common trends allows us to apply a differences-in-differences research design to infer how these statewide mandates impacted the three variables of interest.

```
> reg3 <- lm(emp_combined ~ post_stay + ca + did_stay, data = dat_state)
> coeftest(reg3, vcov = vcovHC(reg3, type = "HC1"))

t test of coefficients:

              Estimate  Std. Error   t value  Pr(>|t|)
(Intercept)  0.00614683  0.00020623   29.8060 < 2.2e-16 ***
post_stay   -0.07311779  0.00055693 -131.2871 < 2.2e-16 ***
ca           0.01062206  0.00130381    8.1469 3.953e-16 ***
did_stay    -0.02860349  0.00296145   -9.6586 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
> # spending:
> reg2 <- lm(spend_all ~ post_stay + ca + did_stay, data = dat_state)
> coeftest(reg2, vcov = vcovHC(reg2, type = "HC1"))

t test of coefficients:

              Estimate  Std. Error  t value  Pr(>|t|)
(Intercept) -0.00578600  0.00060619  -9.5448 < 2.2e-16 ***
post_stay   -0.03294447  0.00107314 -30.6991 < 2.2e-16 ***
ca           0.01106029  0.00272124   4.0644 4.831e-05 ***
did_stay    -0.09851265  0.00597058 -16.4997 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
> # cases:
> reg1 <- lm(new_case_rate ~ post_stay + ca + did_stay, data = dat_state)
> coeftest(reg1, vcov = vcovHC(reg1, type = "HC1"))

t test of coefficients:

             Estimate Std. Error  t value Pr(>|t|)
(Intercept)  0.0228002  0.0020232  11.2695   <2e-16 ***
post_stay   23.6087320  0.1753582 134.6314   <2e-16 ***
ca           0.0053281  0.0087306   0.6103   0.5417
did_stay     0.1053769  1.4649931   0.0719   0.9427
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 4. Differences-in-differences tables estimating employment, spending, and health changes as a result of lockdowns. The estimated difference is contained in "did_stay".

Though differences-in-differences does not provide statistically significant evidence as to the 3/19/20 stay-at-home order's impact on COVID-19 cases, it does reveal that lockdown policy had interesting effects on employment and spending. In particular, the differences-in-differences estimates of -0.03 for employment and -0.1 on spending indicate that the lockdown mandate very likely had negative impacts on both of these variables.

```
> # employment:
> reg6 <- lm(emp_combined ~ post_open + ca + did_open, data = dat_state)
> coeftest(reg6, vcov = vcovHC(reg6, type = "HC1"))

t test of coefficients:

              Estimate Std. Error  t value  Pr(>|t|)
(Intercept) -0.0712043  0.0011691 -60.9035 < 2.2e-16 ***
post_open    0.0240789  0.0012371  19.4642 < 2.2e-16 ***
ca           0.0032845  0.0083398   0.3938  0.693712
did_open    -0.0245770  0.0084994  -2.8916  0.003837 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
> # spending:
> reg5 <- lm(spend_all ~ post_open + ca + did_open, data = dat_state)
> coeftest(reg5, vcov = vcovHC(reg5, type = "HC1"))

t test of coefficients:

              Estimate Std. Error  t value  Pr(>|t|)
(Intercept) -0.1014791  0.0015074 -67.3217 < 2.2e-16 ***
post_open    0.0958566  0.0016940  56.5865 < 2.2e-16 ***
ca          -0.0434201  0.0139557  -3.1113  0.001865 **
did_open    -0.0415335  0.0144679  -2.8707  0.004099 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
> # cases:
> reg4 <- lm(new_case_rate ~ post_open + ca + did_open, data = dat_state)
> coeftest(reg4, vcov = vcovHC(reg4, type = "HC1"))

t test of coefficients:

             Estimate Std. Error  t value Pr(>|t|)
(Intercept)  3.422978   0.083914  40.7914   <2e-16 ***
post_open   23.560802   0.214553 109.8134   <2e-16 ***
ca          -1.699835   0.188653  -9.0104   <2e-16 ***
did_open     2.460140   1.672095   1.4713   0.1412
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Figure 5. Differences-in-differences tables estimating employment, spending, and health changes as a result of business reopenings.

Similarly, differences-in-differences did not give a statistically significant indication as to the effect of the 5/22/20 reopening order on COVID-19 case rate, but it did give some insight to changes in employment and spending. The estimates of -0.025 for employment and -0.04 for spending both indicate that the reopening mandate also likely had negative impacts on both of these variables. This is surprising, as I would expect a state reopening to have the opposite effect of a state lockdown. However, given the severity of the pandemic, any policy, no matter its expected effects, would likely still result in negative results in employment and on the economy. The larger absolute values of the stay-at-home differences in differences estimators suggest that the California lockdown orders resulted in a more strongly negative effect on the labor and consumer markets than reopening orders did.

Descriptive analysis and causal inference offer surprising insights into the effectiveness of California’s COVID-19 strategy. California’s disparity in employment recovery compared to public health recovery lends support to the notion that there is indeed a tradeoff between policies that protect public health and policies that promote labor market health. While California has

achieved a very low April 2021 case rate compared to nearby states, employment has not seen the same recovery, which could point to an inverse relationship between public health and employment. Additionally, while lockdown policy has an inconclusive causal impact on public health, it does likely have a detrimental effect on employment, as shown by conducting differences-in-differences causal inference. These analyses all are consistent with the belief in a tradeoff between public-health-driven policy, like stay-at-home orders, and labor-driven policy, like business openings. Assuming this is true, California's COVID containment may have come at the cost of weakening employment levels. Given that employment recovery has lagged significantly behind public health recovery, it may make more sense for policy to shift its focus toward reinvigorating the labor market.

Observing long-run trends between states could also give some insight as to whether or not earlier lockdowns result in better long-run economic impacts. California, Arizona, and Oregon all implemented stay-at-home orders in mid-March, while Nevada only began lockdowns in April. As of April 2021, all of the states with earlier lockdowns had recovered spending to at least pre-pandemic levels, while Nevada still had a level of spending nearly 3% lower than pre-pandemic, which is significantly lower than the national average recovery. There are of course many other unaccounted variables at play, which precludes us from drawing causal inferences, but these differences are still interesting. The observations are consistent with the belief that even though stringent lockdowns result in decreased economic activity initially, they benefit market health in the long run. This belief, if true, would suggest that California made the right decision to enact strict stay-at-home orders early in the pandemic.

As mentioned before, my analysis does have significant caveats, as many of my speculations are based upon observed trends and associations as well as incomplete data in the

case of employment in California. Other than the inferences drawn from differences-in-differences, these results do not give insight into causal links. Nevertheless, this exploration of California's public health and economic outcomes is helpful toward estimating the efficacy of prior response measures as well as suggesting next steps toward the state's continued employment and spending recovery.