1. Title
Internal and External Effects of Social Distancing in a Pandemic

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3. Abstract
We use a conventional dynamic economic model to integrate individual optimization, equilibrium interactions, and policy analysis into the canonical epidemiological model. Our tractable framework allows us to represent both equilibrium and optimal allocations as a set of differential equations that can jointly be solved with the epidemiological model in a unified fashion. Quantitatively, the laissez-faire equilibrium accounts for the decline in social activity we measure in US micro-data from SafeGraph. Relative to that, we highlight three key features of the optimal policy: it imposes immediate, discontinuous social distancing; it keeps social distancing in place for a long time or until treatment is found; and it is never extremely restrictive, keeping the effective reproduction number mildly above the share of the population susceptible to the disease.

4. Data description
We work with micro-data from SafeGraph. Among other things, SafeGraph provides highly disaggregated and detailed high-frequency information on individual travel in the United States. The population sample is a panel of opt-in, anonymized smartphone devices, and is well balanced across US demographics and space.

In early April 2020, SafeGraph made two datasets freely available to researchers. Their first “Covid-19 Response Dataset,” named “Weekly Patterns,” registers GPS-identified visits to Points of Interest (POI) (primarily businesses) with exact known location in the United States at hourly frequency in a balanced panel. The data is currently available covering the period March 1 to April 11, 2020. The dataset is large. On March 1, the dataset recorded approximately 32.1 million individual visits to approximately 3.9 million POI.

The second dataset, named “Social Distancing Metrics,” uses information from individual cell devices that can be assigned to a home address (using their night-time location) to measure individual foot traffic and its response to the outbreak. The dataset goes back to January 1, 2020 and currently, runs until April 9 and is likewise large. On March 1, the dataset contains information from over 20 million devices across 220,000 census block groups with at least 5 devices. Among other things, the data measures for each census block group the median number of minutes a device dwells at its home location (variable median_home_dwell_time). In addition, it also measures the number of devices that spend the entire day-of-week at the home location (variable completely_home_device_count).

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1 Attribution: SafeGraph, a data company that aggregates anonymized location data from numerous applications in order to provide insights about physical places. To enhance privacy, SafeGraph excludes census block group information if fewer than five devices visited an establishment in a month from a given census block group.
2 For detailed information, see https://docs.safegraph.com/docs/weekly-patterns and https://docs.safegraph.com/docs/social-distancing-metrics.
We construct our measures at the state level. We use the first dataset to count the total daily number of visits, for each state, to POIs. We proceed identically for our other two measures. We subtract the median minutes spent at home from $24 \times 60 = 1440$ and take a daily state-wide average. We similarly construct the state-wide fraction of all devices that leave the house at least once during any day. We express all three variables relative to a baseline week (dividing by the corresponding day during the first week of March). This gives us, for each state, three different measures of the decline of social activity that naturally map to the model.

5. JEL codes for the project
   E1, I1, H0

6. Key-words
   Epidemic, COVID-19, social distancing, basic reproduction number, effective reproduction number, social activity, individual optimality, containment policy, SIR model

7. URL
   https://drive.google.com/file/d/19VzxOwO2JPhCVDzdip173D9xcSD9wnwD/view