Bringing it all back home
Part II

PEAS 2022-2023

1. INTRODUCTION

INTRODUCTION

- The nature of many environmental problems makes understanding the evolution of technology an important part of projecting future policy impacts.
- Environmental technologies include technologies that reduce pollution at the end of the pipe and changes to the production process that lead to reduced environmental impacts.
- Because the benefits of environmental technologies tend to accrue to society at large market forces alone provide little incentive for developing environmental technologies.
- Instead, environmental regulation or public funding of R&D often provides the first impetus for developing new environmental technologies.

INTRODUCTION

- Understanding the environmental impact of overall technological change is also important to assess the long-term sustainability of economic growth.
- The environmental impact of economic activity is affected by the rate and direction of technological change.
- New technologies may create or facilitate increased pollution, or may mitigate or replace existing polluting activities.
- Further, because many environmental problems and policy responses are evaluated over time horizons of decades or centuries, the cumulative impact of technological changes is likely to be large.

INTRODUCTION

- Consider climate change: different assumptions about the potential for future technological change lead to greatly different assessments about both the potential for reducing carbon emissions and the optimal rate at which such reductions should occur.
- For instance, in its latest report on climate change, the Intergovernmental Panel on Climate Change (IPCC) reports estimates of the costs of stabilizing global carbon concentrations from a variety of climate models.
- To stabilize concentrations at a level of 550 parts per million (ppm), the estimated costs range from a four percent loss to a slight increase in GDP, relative to baseline growth.

INTRODUCTION

So, after a couple of "bringing it all back home" lectures on data and empirics, we now try and walk the same path for theoretical issues.

2. SOME KEY CONCEPTS

EXTERNALITIES

- Economic analysis of environmental policy is based on the idea that the potentially harmful consequences of economic activities on the environment constitute an "externality."
- The firm that owns the factory has an economic incentive to use only as much labor or steel as it can productively employ, because those inputs are costly to the firm.
- Costs relative to steel and labor are thus internalized by the firm.
- But the firm does not have an economic incentive to minimize the external costs of pollution.

EXTERNALITIES

- Environmental policies attempt to equalize this imbalance by raising the incentive for a firm to minimize these externalities.
- Policy choices accomplish this in one of two general ways—either by financially internalizing the environmental costs so polluters make their own decisions regarding their consumption of environmental inputs . . .
- . . . or by imposing a limit on the level of environmental pollution.

EXTERNALITIES

- The cost of environmental policies could be in the form of:
  - decreased output of desired products,
  - increased use of other variable inputs,
  - purchase of specialized pollution control equipment,
  - substitution of inferior or more expensive products or production methods to avoid pollution-causing products or methods (for example, less effective pesticides used when DDT was banned).

EXTERNALITIES

- In the short run, setting an efficient environmental policy requires a comparison of the marginal cost of reducing pollution with the marginal benefit of a cleaner environment.
- All else being equal, emissions of pollutants that are very harmful should be greatly restricted, because the pollutants otherwise produce large marginal costs to society.
- But, all else being equal, emissions of pollutants that are very costly to eliminate should be tolerated, because the marginal cost of reducing them is high.

EXTERNALITIES

- When technology enters the equation, the terms of the tradeoff between the marginal cost of pollution control and its marginal social benefit is altered.
- In particular, technological innovations typically reduce the marginal cost of achieving a given unit of pollution reduction.
- In most cases, technological change enables a specified level of environmental cleanup to be achieved at lower total cost to society.
- New innovations also make it possible for a lower total level of pollution to be attained more efficiently than would be expected if the cost of cleanup were higher.

ECONOMICS OF TECH CHANGE

- As environmental economic research on technological change has grown, the importance of considering market failures for knowledge, as well as traditional environmental externalities, has been emphasized.
- In particular, calls for increased government support for environmentally-friendly R&D are motivated by the need to overcome such market failures.

ECONOMICS OF TECH CHANGE

- The generation of knowledge through the innovative process contrasts sharply with the negative externalities from pollution.
- Because of the public goods nature of knowledge, a firm that invests in or implements a new technology typically creates benefits for others while incurring all the costs. The firm therefore lacks the incentive to increase those benefits by investing in technology.
- Pollution creates a negative externality, and so the invisible hand allows too much of it. Technology creates positive externalities, and so the invisible hand produces too little of it.
- As such, even if policies to correct the environmental externalities are in place, the level of environmental R&D will still be suboptimal. Because they ignore the positive spillovers created by R&D, firms will underinvest in research activity.

- Uncertainty is also an issue for innovation. While all investments are characterized by uncertainty, the uncertainty associated with the returns to investment in innovation is often particularly large.
- Not only is the variance of the distribution of expected returns much larger than for other investments, but much or even most of the value may be associated with very low probability but very high value outcomes.
- Uncertainty may prove particulary problematic for environmental policy, as the technologies needed to comply with proposed regulations may evolve in unexpected ways once policy is in place, making it difficult for regulators to anticipate the true costs of compliance.

ECONOMICS OF TECH CHANGE

- More recently, economists have come to understand additional market failures that may operate in the adoption and diffusion of new technology.
- For a number of reasons, the cost or value of a new technology to one user may depend on how many other users have adopted the technology. In general, users will be better off the more other people use the same technology.
- This benefit associated with the overall scale of technology adoption has sometimes been referred to as "dynamic increasing returns," which may be generated by learning-by-using, learning-by-doing, or network externalities.
- Thus, just like the creation of the technology itself, information about the performance of a technology has an important public goods component.

3. IMPLICATIONS FOR ENVIRONMENTAL AND TECHNOLOGY POLICY

ENVIRONMENTAL AND TECHNOLOGY POLICY

- The combination of environmental externalities and knowledge market failures provide two hurdles for policy makers to address when providing incentives for environmental innovation, and suggests two possible avenues through which policy can encourage the development of environmentally-friendly technologies:

  1. correcting the environmental externality
  2. and/or correcting knowledge market failures.

ENVIRONMENTAL AND TECHNOLOGY POLICY

- Because knowledge market failures apply across technologies, policies addressing knowledge market failures may be general, addressing the problem in the economy as a whole, such as patent protection, R&D tax credits, and funding for generic basic research.
- Such policies focus on the overall rate of innovation – how much innovative activity takes place.
- In contrast, policies aimed specifically at the environment focus on the direction of innovation.

ENVIRONMENTAL AND TECHNOLOGY POLICY

- Studies evaluating the effectiveness of these various policy options find that environmental and technology policies work best in tandem.
- While technology policy can help facilitate the creation of new environmentally-friendly technologies, it provides little incentive to adopt these technologies.

Uncertainty over future policies I

- An additional problem resulting from the long time frame of environmental concerns such as climate change is uncertainty over future policies.
- Consider, for example, a firm planning research on fuel cells for cars. Given that such technologies are not currently competitive with traditional fuel sources, and that sufficient policies are not in place to overcome these cost differences, what matters to the firm is not the effective price of carbon emissions today.
- Rather, it is the expected price of carbon emissions a decade or more in the future, when the vehicle might actually be on the market.

- Such long-term issues arise often when studying problems such as climate change, and raise the question of whether additional policy measures are needed that either ...
- ... enable the government to manipulate expectations of future prices or ...
- ... perform the initial research necessary to get ground-breaking technologies close to market, thus lowering the cost (and raising political support for) future environmental policy.
- That is, one can look at this question as whether environmental policy should come first, and be designed in a way to encourage long-run innovation, or whether technology policy needs to accompany or precede environmental policy, so as to lower the costs of implementing environmental cleanup.

4. GREEN TECHNOLOGIES: FIRST SET OF CONCLUSIONS

- Technological change plays a key role in environmental policy.
- While new technologies can make cleaner production and more efficient resource use possible, markets are unlikely to provide proper incentives for the development of clean technologies, absent public policy.
- As in other areas of technological change, knowledge spillovers lead to underinvestment in R&D by private firms.
- However, even if all knowledge market failures were addressed, firms would still underinvest in environmental R&D, as many of the benefits to providing a cleaner environmental are external.
- By addressing the externality problem, environmental policy increases incentives for environmental R&D.

- Much of the research discussed in our classes addresses the links between environmental policy and innovation.
- While any environmental policy should provide some additional incentive for environmentally-oriented R&D, environmental economists have focused much research on how the proper design of policy will lead to greater innovation.
- In particular, flexible policy instruments that provide rewards for continual environmental improvement and cost reduction tend to have better dynamic efficiency properties than policies that specify a specific behavior.

– Measuring the effects of environmental technological change is equally if not more challenging. There are three main challenges here.

First challenge

- Because policy is needed to encourage adoption of environmental technology, one needs to separately identify the effects of both environmental policy and innovation to ascertain the gains from environmental technological change.

Second challenge

- Moreover, while innovation on alternative energy sources has increased in recent years, diffusion is still slow, as these technologies still are not cost competitive with fossil fuels without policy intervention.
- As a result, while there are good data on the cost of traditional energy sources, due to thorough market penetration, quality data on the cost savings accruing from early research on alternative energy sources are lacking, as such technologies have yet to become well- established in the market place.
- The data that do exist are often aggregate in nature, making identifying the various effects of R&D, experience, and policy difficult.

Third challenge

- A third challenge for estimating the effects of environmental technological change is the role of government R&D, particularly with respect to environmentally-friendly energy R&D.
- Government R&D is particularly important for energy, where many technologies are still years from being commercially viable. The combination of long-term payoffs and high uncertainty make government R&D a popular policy choice. However, there is little research evaluating the effectiveness of these programs.

5. FOOD ECONOMICS: SECOND SET OF CONCLUSIONS

- The global food system can be defined as the production, processing, and distribution of food throughout the world.
- Food security for an individual within this global food system is characterized by the Food and Agriculture Organization of the United Nations (FAO) as having the following four dimensions:

    1. availability of food
    2. economic and physical access to food
    3. food utilization to reach a state of nutritional well-being
    4. and the stability of the previous three dimensions over time

- However, our current food system is rife with inequalities and issues that prevent adequate food security for all, and have consequences for individuals as well as our global environment.
- Here are the top four problems with the global food system.

TOP PROBLEM #1

Increased Biofuel Production I

- Biofuels are fuels derived from organic matter as opposed to fossil fuels.
- Thought to be a valuable alternative to fossil fuels, many farm subsidies have been put into place to promote the production of these crops.
- Yet not only have biofuels proven to be more harmful to the environment than expected, they can also be potentially devastating to the food system.

TOP PROBLEM #1

Increased Biofuel Production II

- Increased devotion of agricultural land to produce food-based biofuels has resulted in global displacement of people and rise in food prices.
- Incentives to produce biofuels have raised the global competition for land, and have made it harder for smaller farmers to compete or maintain control of their property.
- Currently, fewer than five corporations control about 47% of all ethanol production in the U.S.
- As more land is concentrated on food-based biofuel production, less is devoted to the growing of crops for consumption.
- The World Resources Institute (WRI) reports that "producing 10% of all transport fuels from biofuels by 2050, as planned by some governments, would require 32% of global crop production but produce only 2% of global energy.

TOP PROBLEM #2

Limited food access

- This is (sadly) well known: The inability to access sufficient amounts of food is an issue that plagues populations globally. Worldwide, about 795 million people suffer from chronic undernourishment.
- This is however less well known: More than 29 million Americans live in "food deserts", which means that they do not have a market within a mile of their home if they live in an urban area, or within 10 miles of their home if they live in a rural area.
- On top of the absence of these markets, limited mobility, economic barriers, and a lack of fresh food options prevent certain low-income communities from obtaining healthy and affordable food.

$\rightarrow$ Have a look at this paper: (downloadable from my UNITE ELEARN): Haskell, S. "Food Insecurity and Food Deserts: How are they Related?", Michigan State University, 2021.

TOP PROBLEM #3

Unsustainable agricultural practices

- According to FAO, agricultural production is a huge driver of climate change, producing one-fifth of total greenhouse gas (GHG) emissions.
- Intensive farming methods use fertilizers and pesticides that contaminate streams and rivers that can create downstream "dead zones," and deforestation for agricultural use accounts for an estimated 10-11% of global GHG emissions.
- Big agribusinesses utilize poor agricultural practices to cut production costs, and, due to these practices, 5-10 million hectares of arable farmland become unusable every year, with an additional 0.3-1.5 million becoming unproductive as a result of salinization and water logging.

Top Problem #4

Lack of farmers and workers rights

- According to the International Food Policy Research Institute's Global Food Policy Report (GFPR), smallholder farmers that farm less than 2 hectares of land make up the majority of agricultural producers for the world, but also make up half of the world's poor and hungry population.
- These smaller farmers are increasingly unable to compete in an agricultural market dominated by big agribusinesses.
- Smallholders have a lack of access to the proper assets, such as tractors and fertilizers, and small farmers that are able to stay in business earn less due to the immense surpluses produced by industrial agricultural companies or are subject to these companies' control.
- For example, being forced to buy Monsanto's patented "transgenic seeds" in order to stay competitive. Therefore, only about 10-20% of the agricultural product value is returned to the farmer and the farmer's rural community.

5. A New Research Topic I Felt in Love with: Food Deserts and Food Swamps

FOOD DESERTS AND FOOD SWAMPS

- According to the U.S. Department of Agriculture (USDA), food deserts are defined as: "[. . .] census tracts where a significant number (at least 500 people) or share (at least 33 percent) of the population is farther than 1/2 mile from the nearest supermarket, supercenter, or large grocery store for an urban area or greater than 10 miles for a rural area."
- By contrast, the term food swamp has emerged to characterize any area (urban or rural) as a "spatial metaphor to describe neighborhoods where fast food and junk food inundate healthy alternatives."
- Research has also found that in the United States, "low- income and racial-ethnic minorities are more likely than whites to live near unhealthy food retailers, which has been associated with poor diet." (Source: Journal of Environmental Research and Public Health, 2017)

FOOD DESERTS AND FOOD SWAMPS

- The USDA identified around 6,500 food deserts.
- It is estimated that around 23.5 million people in the U.S. live in low income areas that are farther than 1 mile to the nearest large grocery store.
- Of these people, 11.5 million have low incomes.
- Explain why grocery stores and/or other classes of stores.

WHERE?

- A 2020 USDA report on food deserts suggests that regions with the following characteristics are more likely to become food deserts:
  - very large or very sparse populations
  - low income (!)
  - high levels of unemployment (!)
  - inadequate access to transportation (!)
  - a low number of food retailers providing fresh produce at affordable prices
- The report also notes that rural areas located in the West, Midwest, and South of the U.S. are much more likely to be food deserts than rural areas located in the Northeast. This may be because rural areas in the Northeast tend to be closer to urban areas.

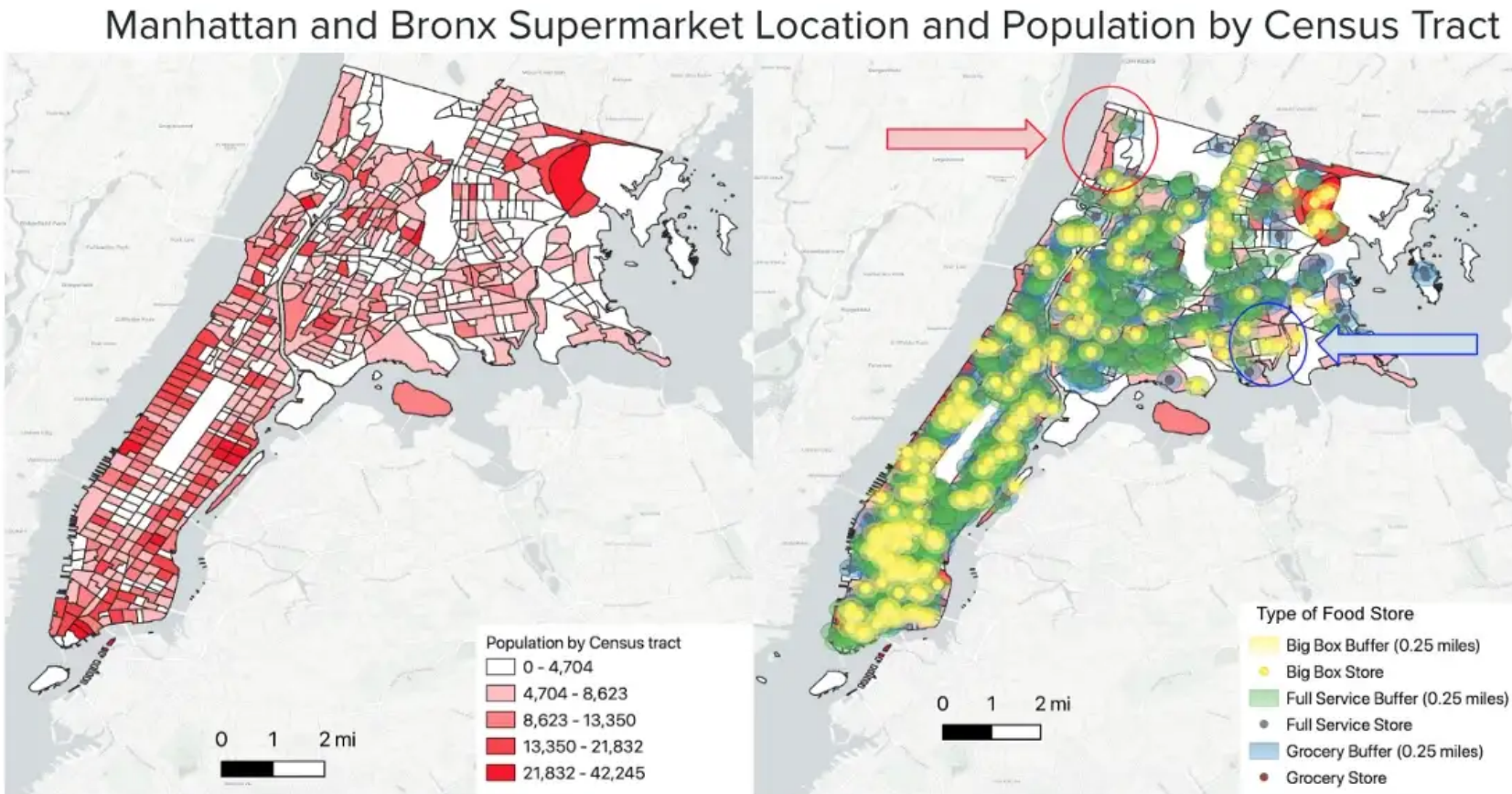
WHY IS IT ANY RELEVANAT?

- Poor diets, like those associated with the intake of processed fast foods, can lead to worse public health outcomes and increased risk for very many diseases.
- This raises important questions such as the reason for oversaturation of access to unhealthy, cheap food in low-income areas,
- How neighborhood demographics most likely influence the actions taken by the food industry and community decision-makers, and the consequences of such choices made by these entities on the built environment and the people living within it.
- Food deserts are usually correlated with poor health outcomes and food insecurity, which means a lack of access to food needed to live a healthy, active life. (Source: Food Bank NYC)

MANHATTAN AND THE BRONX: SOME QUESTIONS

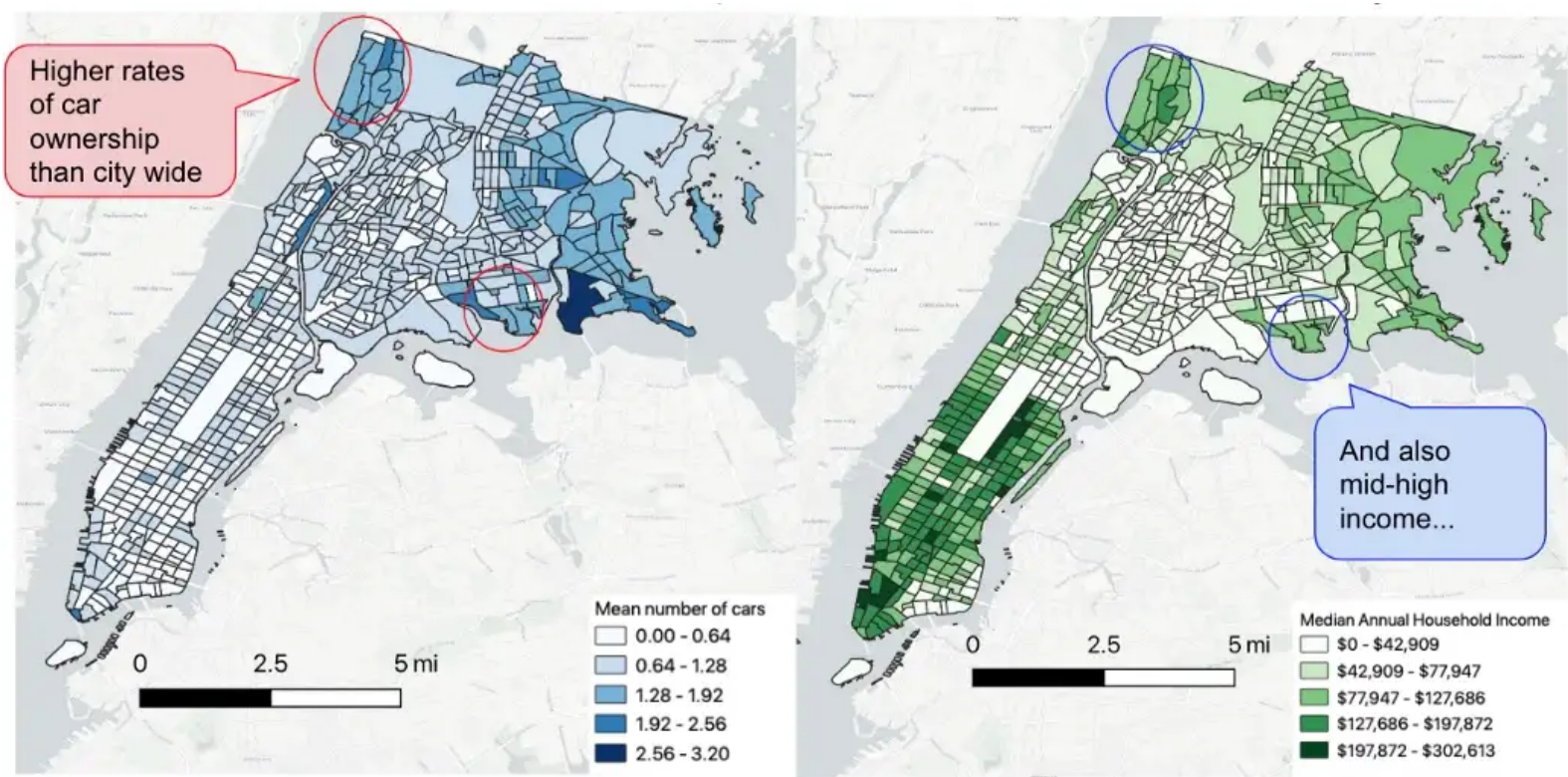
- Are there food deserts in Manhattan and the Bronx? If so, where?
- How accessible are low-income areas to supermarkets in comparison to high- income areas?
- Where are food swamps? Are they correlated with negative health outcomes?

MORE FD IN MANHATTAN AND THE BRONX?



Map 1 Sources: 2010 NYC Census Tracts (Open Data), NYS Retail Food Data (NYS Open Data), 2018 U.S. Census Data (American Community Survey) on Population (Simply Analytics) [Link to QGIS Directions]

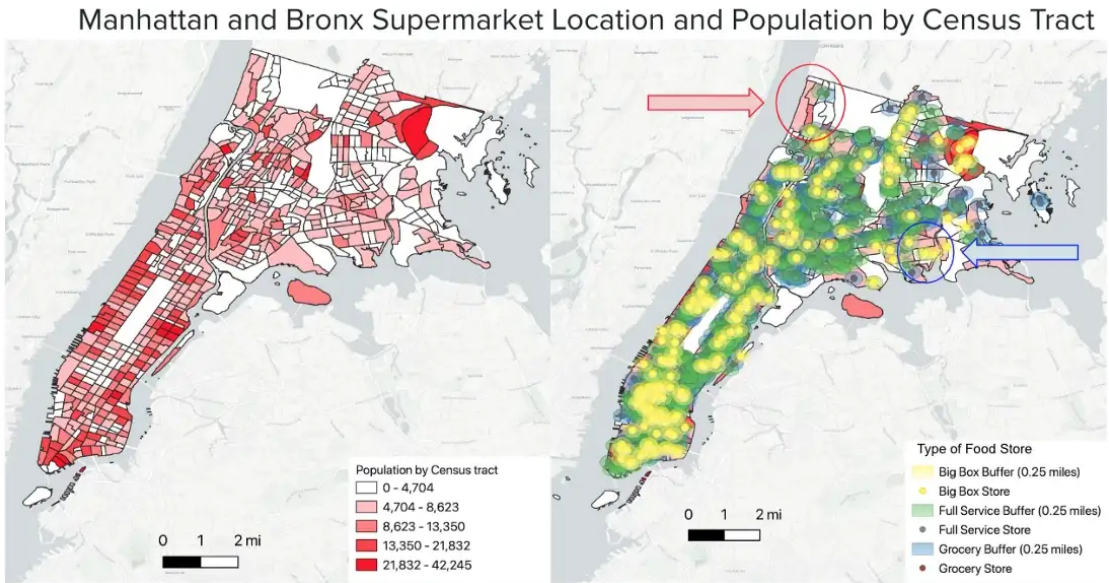
MORE FD IN MANHATTAN AND THE BRONX?



Map 2 Sources: 2010 NYC Census Tracts (Open Data), 2018 U.S. Census Data (American Community Survey) on Median Car Ownership and Median Household Income (Simply Analytics) [Link to QGIS Directions]

EXPLANATION

Looking at Map 1, we see that retail food stores are concentrated in census tracts where there are more people. Broadly speaking, this shows that where there are more people, there is more food to account for the higher population



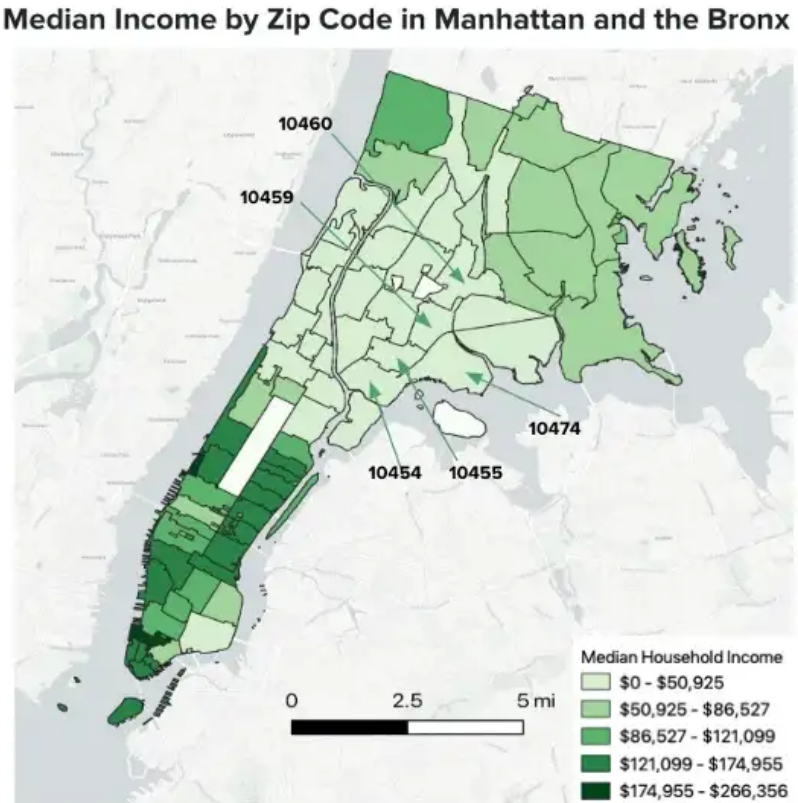
Map 1 Sources: 2010 NYC Census Tracts (Open Data), NYS Retail Food Data (NYS Open Data), 2018 U.S. Census Data (American Community Survey) on Population (Simply Analytics) [Link to QGIS Directions]

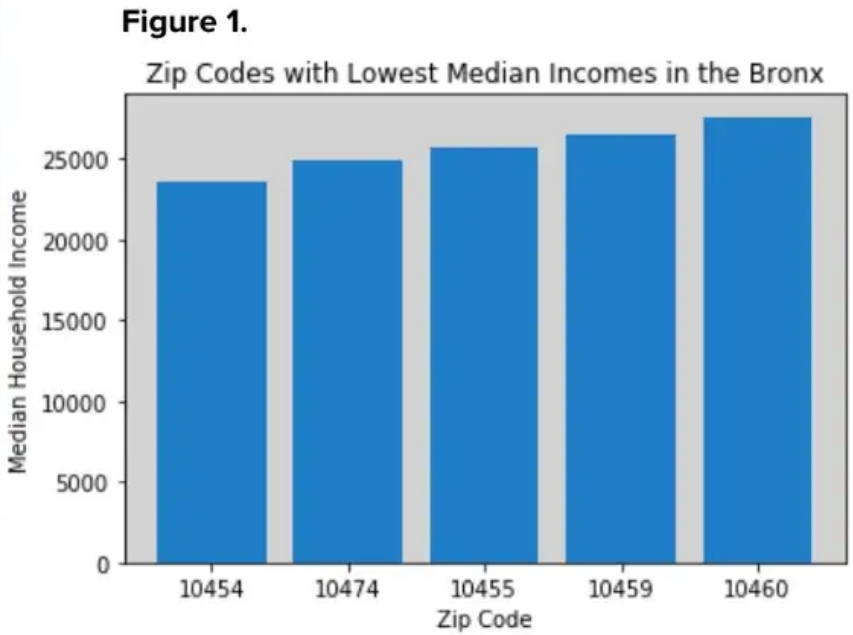
Food retail store locations tend to correlate with the population size in Manhattan and the Bronx.

INCOME?

- After the findings of the first question, it would seem that there are hardly any areas of Manhattan and the Bronx that lack access to food if we were to go off the basic definition of food desert (i.e., physically far removed from a retail food store).
- So next step is to compare high and low-income zip-codes and see how they differ. To see this, we are going to compare what a seven-minute walk looks like from a residential building in the three lowest and three highest income zip codes.
- Consider a map that portrayed median incomes of each zip code of the Manhattan and the Bronx, with darker sections portraying higher income. The lowest income zip codes were largely in the South Bronx, and the highest was in largely in Southern Manhattan (Financial District, TriBeCa, SoHo) and a sliver in Midtown West.
- From here, chose the three most extreme zip codes and analyzed them closer.

POOREST ZIP CODES



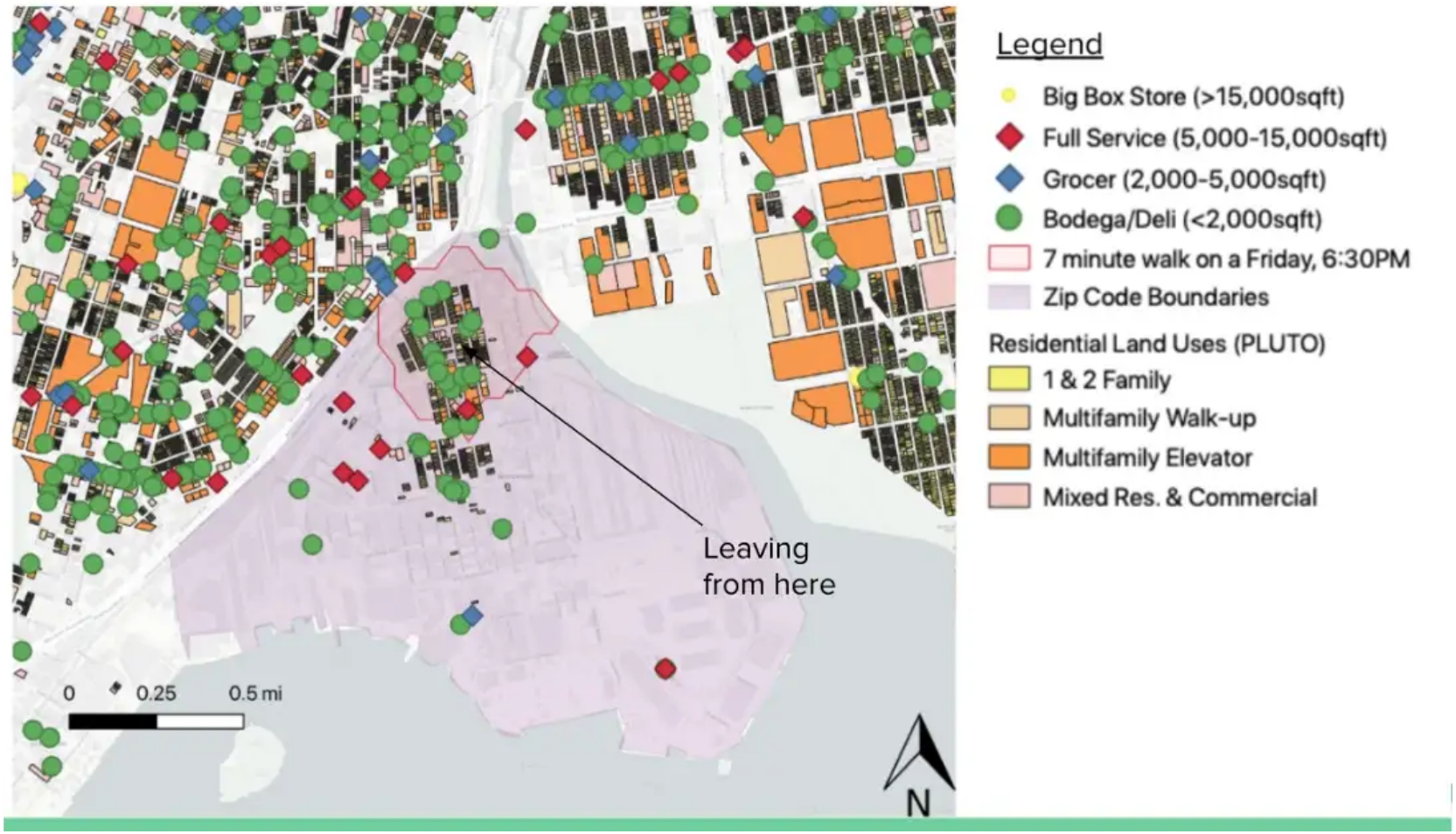


Map 3 Sources: NYC Zip Code Boundaries (Open Data), 2018 U.S. Census Data (American Community Survey) on Median Household Income (Simply Analytics) [Link to QGIS Directions] [Link to Google Colab]

7 MINUTES WALK TO RETAIL FOOD STORE IN 10454 (MOTT HAVEN)

Map 5 Sources: NYC Zip Code Boundaries (Open Data), NYC PLUTO Data (Chris Whong), NYS Retail Food Data (NYS Open Data), Travel Time Platform for QGIS (TravelTime) [Link to QGIS Directions]

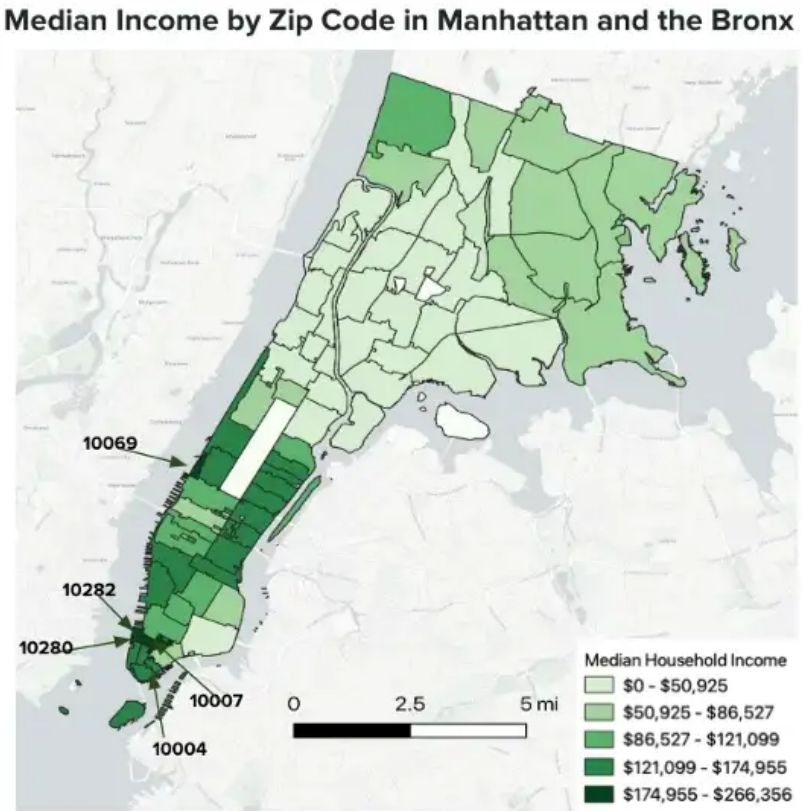
7 MINUTES WALK TO RETAIL FOOD STORE IN 10474 (HUNT'S POINT)

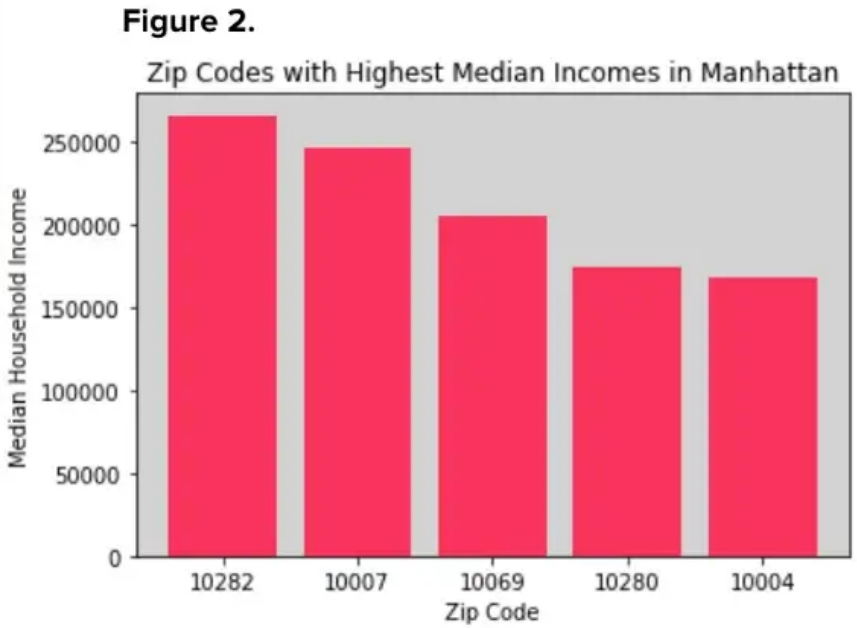


7 MINUTES WALK TO RETAIL FOOD STORE IN 10455 (MOTT HAVEN 2)

Map 7 Sources: NYC Zip Code Boundaries (Open Data), NYC PLUTO Data (Chris Whong), NYS Retail Food Data (NYS Open Data), Travel Time Platform for QGIS (TravelTime) [Link to QGIS Directions]

RICHEST ZIP CODES





Map 4 Sources: NYC Zip Code Boundaries (Open Data), 2018 U.S. Census Data (American Community Survey) on Median Household Income (Simply Analytics) [Link to QGIS Directions] [Link to Google Colab]

7 MINUTES WALK TO RETAIL FOOD STORE IN 10282 (BATTERY PARK)

Map 8 Sources: NYC Zip Code Boundaries (Open Data), NYC PLUTO Data (Chris Whong), NYS Retail Food Data (NYS Open Data), Travel Time Platform for QGIS (TravelTime) [Link to QGIS Directions]

Median Household Income $230,952

7 MINUTES WALK TO RETAIL FOOD STORE IN 10282 (UPPER WEST SIDE)

Median Household Income $170,630

7 MINUTES WALK TO RETAIL FOOD STORE IN 10282 (TriBeCa)

Map 10 Sources: NYC Zip Code Boundaries (Open Data), NYC PLUTO Data (Chris Whong), NYS Retail Food Data (NYS Open Data), Travel Time Platform for QGIS (TravelTime) [Link to QGIS Directions]

Median Household Income $216,037

MAIN FINDINGS

- With the exception of zip code 10282, big-box stores tended to only be within walking distance for the other two Manhattan/highest-income zip codes.
- The three Bronx/low-income zip codes lacked big-box stores but seemed to have more full-service, grocers and bodegas/delis than the Manhattan/high-income zip codes.
- The most noticeable difference between the high and low-income areas was that the low-income areas had significantly more bodegas/delis, despite not being more concentrated than the high-income areas.

MEANING?

- Traditional knowledge about food deserts tells us that poorer areas tend to have less food access than wealthier areas.
- However, here, we see that is not the case. The low-income areas seem to have more food access.
- This begs the questions — what kind of food access is this? What is the quality of the food? Can residents afford what is sold to them in these retail food stores?
- Bodegas and delis have a reputation for being less healthy than a traditional grocer, as they mostly do not sell fresh fruit and vegetables. However, the other three types of retail food stores most likely sell fresh produce. This leads us to our next question about food swamps...
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