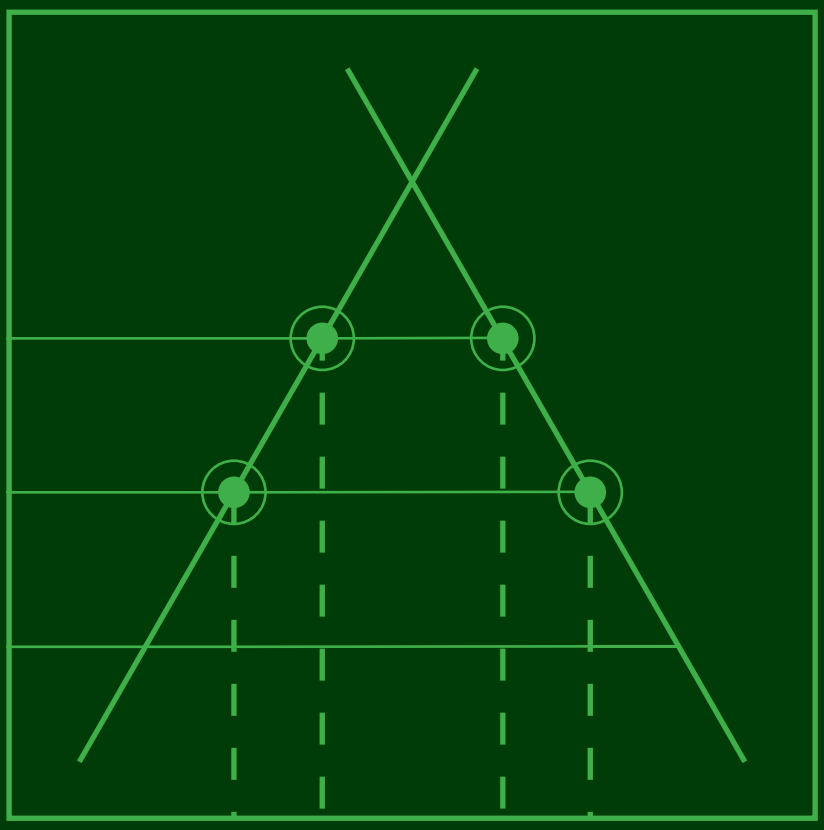
Federal Reserve Bank of Philadelphia

Economic Insights

Second Quarter 2020
Volume 5, Issue 2



Contents

Second Quarter 2020 Volume 5, Issue 2

Economic Insights

A publication of the Research Department of the Federal Reserve Bank of Philadelphia

Economic Insights features nontechnical articles on monetary policy, banking, and national, regional, and international economics, all written for a wide audience.

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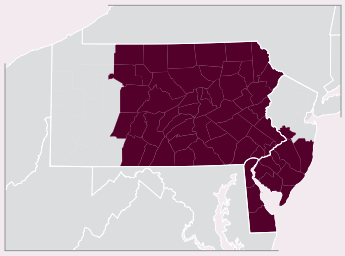

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About the Cover

Tariff

A tariff is a tax placed on imports. This issue's cover depicts the economic costs and benefits of tariffs. The horizontal axis represents the amount of a good consumed by an economy; the vertical axis represents its price. The bottom horizontal line represents the price and supply of that good if there is no tariff. As you can see, without a tariff, there's plenty of supply at a rather low price. A tariff, however, should raise the price and decrease the supply. Each of the upper two horizontal lines represents a different tariff level. In other words, a tariff lifts the horizontal line—and thus the price—to its new location, but it also reduces consumption of that good. This graphic helps economists measure the new tariff's consumer loss, producer gain, and government revenue gain—each of which is depicted by different, and at times overlapping, polygons.

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Chris Severen is a senior economist at the Federal Reserve Bank of Philadelphia. The views expressed in this article are not necessarily those of the Federal Reserve.

A Ticket to Ride

Estimating the Benefits of Rail Transit

Starting in 1990, Los Angeles County built a new and expensive rail transit system. Now we can calculate the costs and benefits.

BY CHRIS SEVEREN

Transportation infrastructure shapes the spatial fabric through which we thread our daily travel. How do we get to work or to school? Where do we go shopping? How long does it take to meet up with friends? Is it worth driving or taking rideshare? Public transit systems—including buses, streetcars, rail lines, and ferries—play a key role in determining our daily travel patterns. Rail transit (subways, light rail, and regional rail) has traditionally been important in older northeastern cities like New York and Philadelphia. Since the 1970s, though, many other cities in the U.S. have sought to increase the mobility available to their residents by building rail transit infrastructure, too.

Building rail is costly and requires large initial public investment. Do the benefits of rail infrastructure outweigh their high costs in younger, more automobile-oriented cities? This is an open question in the U.S., where many cities are polycentric (they have many employment centers rather than a single urban core) and typically not very dense.[1] These factors limit how easy it is for rail transit to connect home to work and other destinations. It is difficult to cost-effectively serve a disperse population that travels to disperse locations with public transit. Further, rail transit infrastructure tends to be very costly in the U.S.

In this article, I discuss why mobility is important and provide an overview of the different ways economists measure the benefits of transit infrastructure. I then describe my hybrid approach, in which I combine three of these methods to study the value of rail transit in Los Angeles.[2] I conclude by conducting a cost-benefit analysis of the first wave of Los Angeles Metro Rail and interpreting the results of this analysis.

LA METRO RAIL IN 2000

Lines 4

Stations 46

Average Weekday Ridership 174,554

860,579
Passenger miles

Source: 2000 National Transit Database.

Why Does Mobility Matter?

Mobility allows people to access places. The more mobile they are, the more options they have: They can get to more jobs or schools and choose between more places to shop and find services. Being able to access many different workplaces, consume varied goods, and meet with lots of different people is one of the big advantages of living in a city. (Before the modern era of automobile and rail infrastructure—that is, when everyone walked or traveled by horse—most firms were small and people worked and consumed more locally.[3]) Even our network of friends depends on the transportation network.[4]

Greater mobility allows cities to be larger, enabling the comparative advantage of cities in productivity,[5] and one of the most important components of urban mobility is commuting: how workers get to their jobs. Cities let workers connect with a variety of jobs, and firms with a variety of workers. Diverse, productive labor markets make cities the engines of economic growth.[6]

Commuting behavior depends on available transportation infrastructure. Indeed, much transportation infrastructure is designed with peak commuting capacity in mind. (Commuting is, after all, an everyday activity essential to the function of urban economies.) People and firms benefit when this transportation infrastructure makes commuting easier. As an extreme example, in their 2015 paper Ferdinando Monte and his coauthors calculated that prohibiting commuting across county lines would decrease aggregate welfare by 7.2 percent, and the effect in central cities (like Manhattan) would be even greater. Better transportation infrastructure can directly increase employment growth. In their 2012 paper, Duranton and Turner showed that cities with more highways in 1983 gained substantially more employment by 2003 than cities with fewer highways.[7] And transportation infrastructure can address (or exacerbate) certain inequalities. For example, long and challenging commutes may affect women more than men: Women tend to work less in cities with very high congestion and long commutes (like New York City) than in cities where commuting is relatively easy (like Minneapolis).[8]

Transit is valuable also because it enables mobility without automobiles. Some people, because of age, disability, or preference, are unable to drive automobiles.[9] Automobiles can be very costly; households with automobiles on average spend 4.3 times as much on transportation as households that do not use automobiles.[10] There are other consequences of automobile use: They are land- and energy-intensive. The average energy cost for automobiles is about 3,180 British thermal units (BTUs) per passenger mile, while urban subways and light rail use only 24 percent of that energy per passenger mile.[11] Moreover, cities with subways tend to be denser, so the average trip distance is shorter.[12] Because cities that rely on the automobile tend to contain more low-density development, they have a higher carbon footprint.[13] Finally, automobile use can lead to severe congestion in cities, causing substantial delays and decreasing mobility in some settings (Figure 1).

How to Quantify the Benefits of Transit

Economists use several methods to evaluate the benefits of transportation infrastructures, and rail transit in particular. Each method has both advantages and disadvantages.

Hedonics

The hedonic approach compares real estate prices near and far from rail. The intuition is that if (identical) people value transit, they are willing to pay more to live near sites of transit access (like subway stations). This increases the demand for residences near transit stations, which then increases the price of nearby housing. This is particularly true if the supply of housing is relatively fixed, and if transit connects people to where they want to go.

In practice, there are several challenges to simply comparing home prices next to and far from transit. Houses or neighborhoods near transit are often substantially different from those further away; they may be older (or newer), denser, or surrounded by a different set of urban amenities (such as restaurants and schools). Real estate prices also reflect expectations

Transportation Spending for Automobile-Owning Households

×4.3

compared to nonowning households

Energy Cost of Automobiles

3,180

BTUs per passenger mile

Energy Cost of Urban Subways and Light Rail

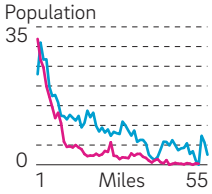
763

BTUs per passenger mile

Density Decreases from Downtown

'000 people/mi² vs. miles from city hall, 2010

Philadelphia vs Los Angeles

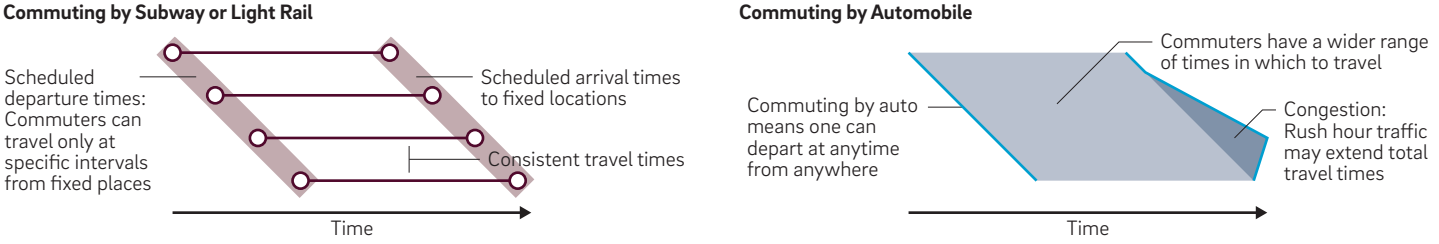


Source: U.S. Census.

FIGURE 1

Commuting Modes Compared

Autos' flexible departure times come at the price of congestion.



about future change. This muddies the interpretation of price gradients near transit. If prices increase in expectation of a transit station opening (that is, before it opens), it could simply be that people expect increases in (nontransit) amenities nearby. So the belief that transit will generate value can make it appear that transit is valued.

It can also be hard to separate the different effects of transit from real estate prices. There may be a mobility benefit that people value, but some real estate price appreciation might instead be due to related transit-oriented development, as new and potentially valuable amenities (such as restaurants and stores) move into an area. Or there could be offsetting negative effects of transit due to the possibility of noise, pollution, or crime.[14] At-grade transportation infrastructure can even serve as a barrier separating neighborhoods from other nearby locations.[15] Careful research design can overcome some of these challenges.[16]

A final challenge with the hedonic approach is that it can be difficult to study demand linkages across space. If people demand more housing near transit and prices rise, these higher prices might cause some people to move to other slightly more distant areas, increasing housing demand and prices in those neighborhoods. The hedonic approach typically compares places with and without transit, and so it misclassifies places without transit as unaffected even if they are indirectly affected by transit.

Modal Choice

Another method compares the relative proportions of people who use different commuting modes to get between similar locations. (Automobile, bus, rail, and walking are all different modes.) By comparing the characteristics (like travel time, average delays, and cost) of the trips that take place on each mode, researchers can calculate how much commuters value these characteristics. For some trips (or along some routes), transit is faster, while for others cars are faster. Comparing these characteristics and the number of people who choose each mode tells us how much people value fast travel, or how much benefit they receive from different trip characteristics. For example, many people value listening to the radio while driving, or reading the paper (or checking Instagram) while riding the train or subway more than they value the speed of either option.

An advantage of this approach is that it can be implemented with a survey, so you can simply ask people about the characteristics of the choices they face and perhaps even the reasons for the choices they make. One challenge with this approach is that researchers must typically assume that they have described all the factors that underlie people's decisions on how to commute. In practice, this can be hard. Many transit modes have highly variable travel times or require waiting for long periods. Both are factors that people particularly dislike, yet both are often ignored.

City Structure

A key tradeoff that drives city structure (and where households and firms choose to locate) is access versus price. Transportation infrastructure allows people better access to inexpensive land. Rail transit does this in a different way than roads, concentrating the benefits of access near transit stations.

People's choices about where to live and work reveal that access is valuable. Aggregating the commuting behavior of people who live in a neighborhood or work in a particular area yields an interesting (though perhaps obvious) conclusion: On average, closer locations have more commuting between them. Economists call this phenomenon gravity, and they have started building spatially explicit models that incorporate this behavior in powerful ways. By combining the notion of gravity with modal choice and transportation data, researchers can estimate the value of increased ease of travel due to transportation infrastructure.[17]

This approach enables researchers to build relatively complex economic models that capture many significant features of urban economies. Moreover, these models typically capture how people move in response to changes in local neighborhoods or commutes. The fact that people move links the demand for housing across space, and can cause local housing prices to reflect changes in other neighborhoods. If this occurs, the hedonic approach will not correctly value these local characteristics, but these more complex models will.

However, this literature has typically assumed that transportation infrastructure only shifts travel outcomes, ignoring other effects it may have. As discussed above, transportation infrastructure can potentially change the quality of residential amenities in a neighborhood or come packaged with zoning policies that increase (or decrease) housing supply. Another challenge facing this literature is that it usually requires a big shock to a city to estimate the models. For example, in their 2015 paper Gabriel Ahlfeldt and his coauthors used the division and reunification of Berlin to estimate their model. It can be challenging to study less extreme settings.

A Combined Approach

Given the different strengths of each of these approaches, there is value in combining them. In my 2019 working paper, I bring together components of these three methods to calculate the total benefits of rail transit. I use spatial data on commuting behavior to directly estimate the commuting effect of transit. I then combine this with hedonic-type estimates of the residential and workplace effects. Finally, I put this all into a model to account for other spillovers across space (Figure 2). The total effect can be decomposed as follows:

Total Effect = (Commuting Effect + Residential Neighborhood Effect + Work Neighborhood Effect) – General Equilibrium Adjustments

I study rail transit in the greater Los Angeles area (Los Angeles and adjacent counties), which has some features that make it particularly valuable as a research subject.

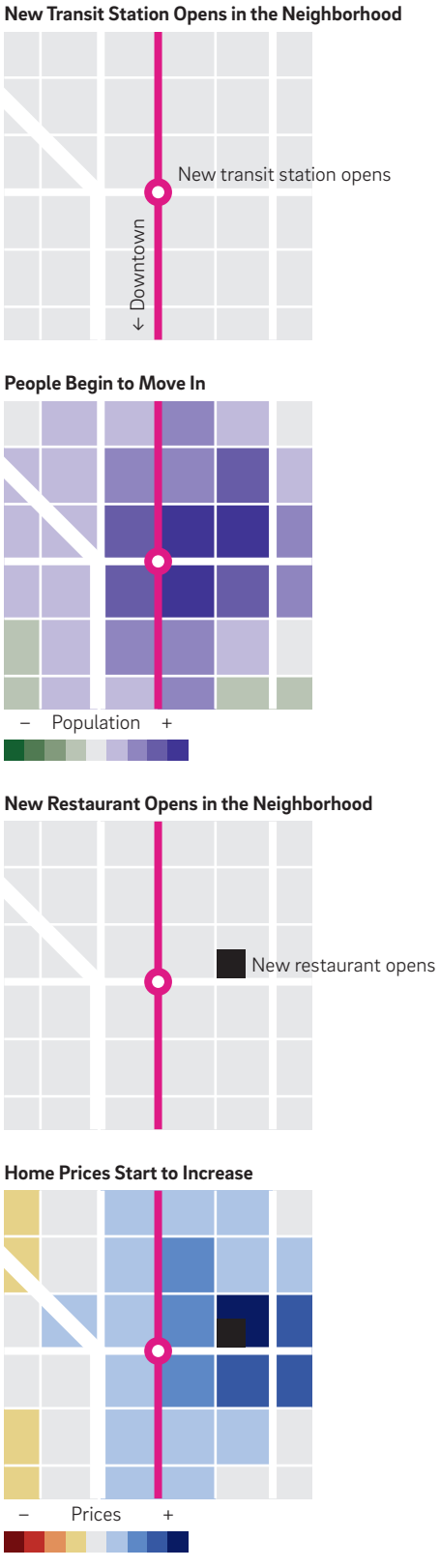
Transit in Los Angeles

The case of Los Angeles offers a number of useful features to evaluate transit. First, greater Los Angeles had no subway or light-rail transit at the beginning of 1990, and it built a relatively

FIGURE 2

Decomposing the Total Effect

There are intermediate steps between the opening of a transit station and an increase in ridership.



large system within 10 years.[18] By 2000, Los Angeles Metro Rail consisted of 46 stations on four lines.[19] This means that it is possible to compare the detailed geography of commuting in Los Angeles before and after rail transit was available. The relatively large system size matters, too. For statistical reasons, it is harder to detect incremental changes if a city adds a few stations (or one line) every decade. Furthermore, there are network effects to transit—the more stations there are (or places that are connected), the more useful the system is and the bigger the benefit.[20]

There's another reason to study Los Angeles Metro Rail. It's relevant for the many automobile-oriented cities considering new subway or light-rail systems. Los Angeles has historically been a poster child for the automobile. It faces many of the transportation issues common to cities that came of age during the automobile era.

Commuting and Noncommuting Effects

To measure the commuting effects of Los Angeles Metro Rail, I use Census Transportation Planning Project data on the number of people who commute from each residential neighborhood to each workplace. I define a neighborhood as a census tract, a unit of measurement used by the Census Bureau.[21] I use data for two years, 1990 and 2000, so that I can look at changes in how many people commute between two tracts. This helps limit the confounding effects of other long-run differences between neighborhoods (or pairs of neighborhoods). I compare the changes in commuting flows between pairs of tracts where both received transit stations and pairs of tracts where at least one did not.

Figure 3 describes the comparisons I make. Transit stations are built in both location A and location B. This means that both of the (directed) pairs AB and BA receive transit. Locations C and D do not receive transit. In total, 10 different pairs do not receive transit: AC, AD, BC, BD, CA, CB, CD, DA, DB, and DC. I compare the average changes in the two pairs that receive transit with the 10 pairs that do not. Better yet, I can also purge the changes at locations A and B that might be caused by the transit station (as well as any other changes that affect only A or B—or C or D, for that matter).[22] This isolates the commuting effect, because the commuting flow between connected locations is the only margin being shifted.

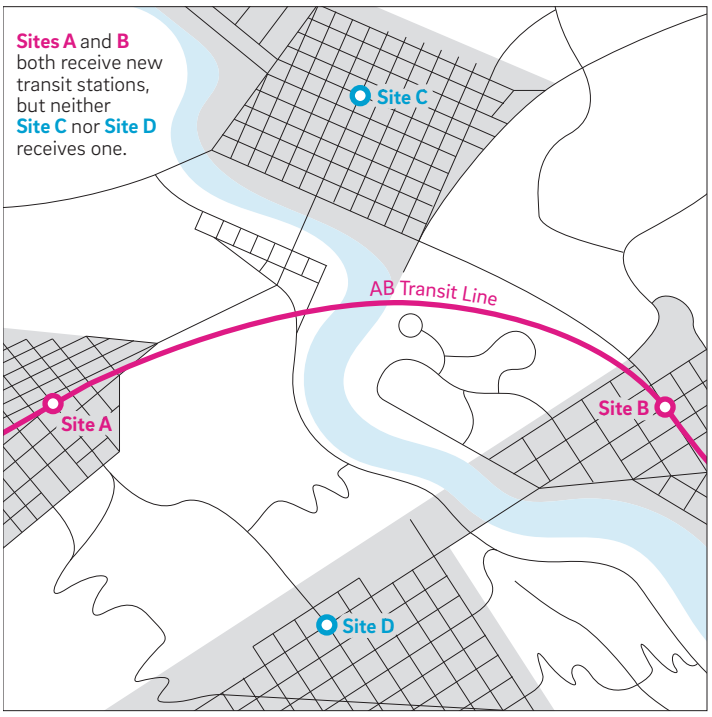
Still, one might worry that these places were connected specifically because planners believed they were most in need of transit connections. If that were so (and if the planners were right), then changes between newly linked neighborhoods might have happened anyway. I limit the control group of neighborhoods (that is, the tracts that did not receive transit linkages) in a couple of different ways to ensure that this is not the case. Both approaches rely on the historical antecedents of Los Angeles Metro Rail to select control neighborhoods that are similar to the neighborhoods that received transit linkages. One approach identifies plausible locations for receiving rail by examining streetcar and interurban rail lines present in the 1920s.[23] Subway and light-rail lines often follow these rights of way, and they tend to align to allow lines to connect. The other comparison uses a historical subway plan from 1925. This plan is more extensive than the subway that was built and so shows many likely routes. Importantly, these routes would have connected historic employment centers and so are less likely to reflect current factors influencing travel demand.

I find strong evidence of a substantial impact of Los Angeles Metro Rail on commuting behavior. Pairs of neighborhoods connected by rail (that is, tracts that both contain stations) experienced a 15 percent increase in commuting between them. Pairs of neighborhoods immediately adjacent to (but not containing) stations saw a 10 percent increase in commuting. More distant places did not see a change (Figure 4). The effect is strongest for pairs of tracts connected by the same subway or light-rail line. (People do not like changing trains, especially when driving is the alternative.) Being close to a station is more important for the workplace location; people seem more willing to walk a moderate distance from home to a station than to walk the same distance from a station to work. Results are consistent across

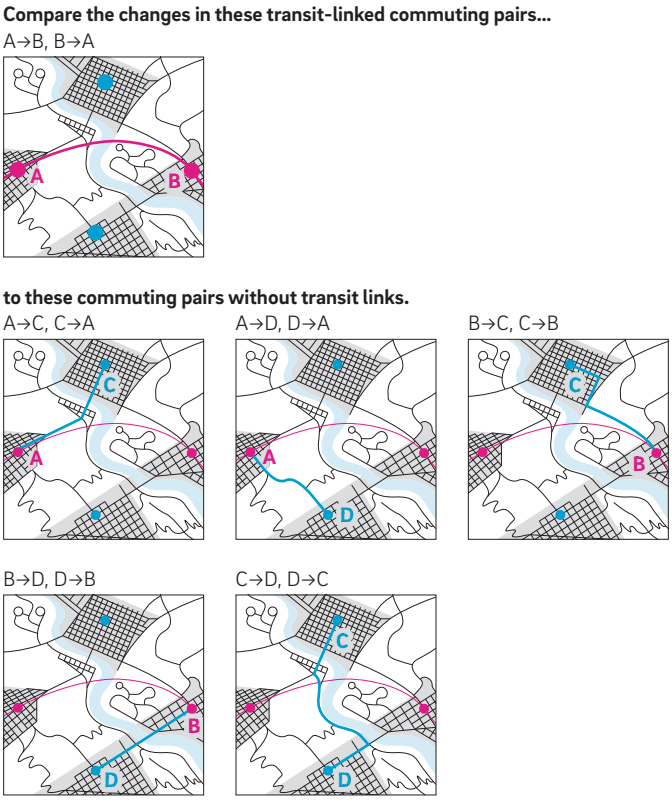
FIGURE 3

Comparing Effects of Transit Stations

By measuring the commuting flow between connected locations, this model isolates the commuting effect.



Note: Locations A and B receive transit stations; C and D do not.



different comparisons, adding strength to their interpretation as a causal effect.

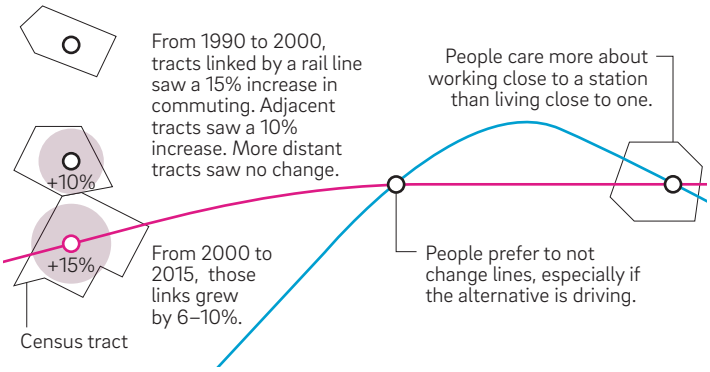
Although my main analysis focuses on the period between 1990 and 2000 (because the data in this period are of the highest quality), commuting may have continued to adjust after the year 2000 in response to the transit linkages built before 2000 that I study. I test for this, and find that commuting between these locations continued to grow relative to other unconnected neighborhoods by 6 to 11 percent over the next 15 years. This delayed effect could be due to slow habituation: It takes people and the built environment a while to adjust to the new transit option. Alternatively, it could be due to the further growth of the Los Angeles Metro Rail network after 2000.[24] People value transit more (and use it more) if it connects them to more places.

There is also evidence of a small reduction in automobile congestion in areas served by rail transit. I compare changes in travel times between pairs of neighborhoods that both lie near a transit station or line with those that do not. Pairs of neighborhoods both within 2 kilometers of a transit line saw a 3 percent reduction in travel time in the long run (though this finding is not the most robust).[25]

Although I find evidence of commuting effects, I find little evidence of noncommuting effects. Residential locations did not, on average, become nicer or worse off because of transit, and workplaces did not become significantly more productive because of transit. These results rely on comparisons between a neighborhood that received a transit station and a neighborhood

FIGURE 4

The Impact of Los Angeles Metro Rail



Source: Author's calculations from Census Transportation Planning Project (CTPP) data.

that did not (rather than comparing a pair of neighborhoods that received a transit linkage to a pair that did not), and so depend more on identifying the correct control group for the comparisons. Nonetheless, there is little evidence of an effect, even when just comparing the neighborhoods most likely to receive transit (as picked out by historic streetcar locations and the 1925 subway plan).[26]

There is also little evidence of a barrier effect. Many transportation projects separate neighborhoods that lie along either side of their routes, driving down the connections to nearby locations.[27] However, the first Los Angeles Metro Rail lines were typically built along existing rail lines, underground, or in highway medians, and so they had little effect.

How Valuable Are These Commuting Effects?

To quantify the monetary value of these effects, I measure how responsive people are to, first, the wages they receive in where they choose to work and, second, the home prices they pay in where they choose to live. The intuition works like this: If a 10 percent increase in wages induces 18 percent more people to work in a location (holding other workplace characteristics constant), then an 18 percent increase in commuting to a location is equivalent to a 10 percent increase in wages.[28] In fact, this 18 percent value is what comes out of the analysis.

The hard part is ensuring that other changes in the workplace or residential neighborhoods do not confound this measurement. For example, if residential housing prices decline because local school quality declines, the local residential population may decrease. Or if employment at the ports goes down because of less shipping due to trade conflicts, the remaining workers could keep receiving the same wage. If I could not account for these other factors, I might conclude that people like higher housing prices and do not care about how much money they make.

Instead of directly trying to account for all the potential factors that could influence these relationships, I try to find something that affects local wages but does not depend on other local factors. I first calculate changes in how productive an industry is, using wages and employment at the national level. I then calculate how much these changes impact each workplace neighborhood based on how much employment in that neighborhood was in each industry in 1990.[29] Overcoming this challenge is a key part of my 2019 working paper, and it (or a similar parameter) is key to translating observed changes to a dollar equivalent in any modal choice or city structure approach.

General Equilibrium Effects

The final component of the analysis is to provide a way to account for spillovers across space. Changes in one neighborhood can affect home prices in other neighborhoods throughout the city because those changes can prompt all households to reevaluate where they want to live, potentially leading some households to move between neighborhoods. This type of general equilibrium effect is important to consider whenever there are large changes to a local economy.

I lightly modify the flexible model of consumer location choice used by Ahlfeldt and his coauthors and apply it to the Los Angeles setting (using the various estimates discussed above). The primary agents in the model are households, who must decide both where to live and where to work. When deciding where to live, they consider residential housing prices and how desirable the neighborhood is. When deciding where to work, they look at what the wages are and how desirable the workplace is. Finally, they also care about how hard it is to travel between a pair of residential and workplace locations.

When transit enters and changes how nice a commute is, or when the characteristics of a neighborhood change, people move. The model makes predictions about the average behavior of people (that is, it tells us where the new population lives but not necessarily who moves where), and so accounts for spillovers in location choice.[30] Housing prices and wages then adjust in response to these changes in where people want to live and work.

Cost-Benefit Comparison and Speculation

Now all the pieces are in place. The commuting effects are measured, there do not appear to be other workplace or residential effects, we have a way to translate these effects into a money-equivalent amount, and we can account for general equilibrium effects.

Combining these pieces, I estimate a benefit of between $109 million and $146 million annually by the year 2000. (The range accounts for whether or not I include the benefits of reduced congestion.) If I include the additional growth in commuting from 2002 to 2015 between locations connected before 2000, the total rises to an upper bound of $216 million annually by 2015.[31] These are purely commuting benefits; they do not account for other travel benefits (such as easing travel for noncommuting trips) or environmental benefits. While these other benefits might be substantial, rail transit is often promoted and judged based on its effect on commuting.[32]

The total cost of the Los Angeles Metro Rail system built by 2000 was $8.7 billion.[33] This can be converted to an annual cost equivalent of between $218 million and $635 million per year.[34] Annual operating subsidies were about $162 million. (These are operating expenses less fare revenue for heavy and light rail.) By summing these numbers, I find that the total annual equivalent cost of Los Angeles Metro Rail as of 2000 was between $380 million and $797 million per year.

The high-end estimates for benefits are therefore about $216 million annually, while the lower end of the costs are at least $380 million annually (Figure 5). This means that there is a sizable discrepancy between the cost of the system and the benefits it delivers even after 25 years.

Why is this the case, and how generalizable is this conclusion? There are two items to consider: How could the benefits have been higher, and how could the costs have been lower.

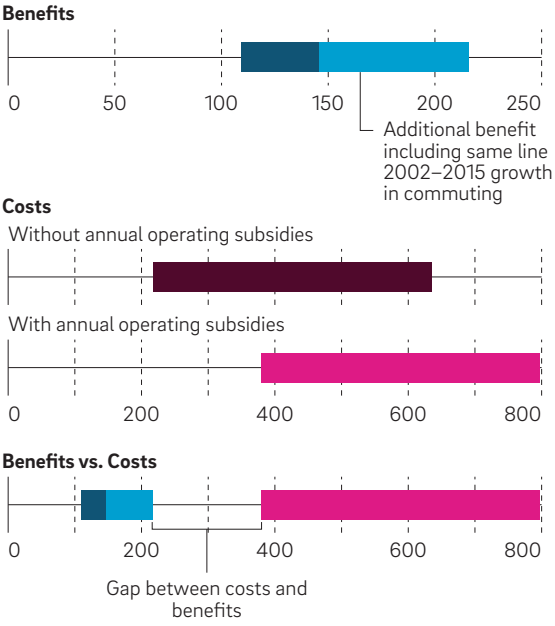
Some of the features that make Los Angeles useful to study mean that a suboptimal system was built. Instead of connecting the densest residential and workplace populations, the subway and light-rail system initially connected many areas between

FIGURE 5

Costs and Benefits of Los Angeles Metro Rail

Despite growth in commuting, there's a sizable discrepancy between costs and benefits.

Range, millions of dollars



Source: Author's calculations based on CTPP; cost numbers from Los Angeles Metro's Adopted Budgets and the U.S. Department of Transportation's National Transit Database.

which there was not a lot of commuting. Restrictive land-use regulations have likely inhibited further development along these rail lines. At the same time, many features of Los Angeles (a polycentric, automobile-oriented city without many high-density areas) are common to other cities building rail transit.

Rail transit construction is generally expensive, and some factors make Los Angeles particularly expensive to build in: Earthquake risk, coastal flooding, and challenging geography all increase costs. What's more, it appears that rail infrastructure typically costs more in the U.S. than in other places.[35] The understanding of why costs are high is still limited. Unfortunately, transit planners are often forced to cut costs by building transit in places where people do not really want to travel, creating a downward spiral in usefulness.

By ridership numbers alone, Los Angeles Metro Rail is actually performing better than the rail transit systems of many other similar cities. In building a relatively large network that begins to cover a geographically large cosmopolis, Los Angeles Metro Rail could serve as the basis of a large transit system integral to mobility in Los Angeles 100 years from now. New York City in 2004 was much larger and denser than it was in 1904, when its first subway line was completed. However, planners and politicians rarely get the latitude or budget to plan on such timescales.

Notes

1 See Anas, Arnott, and Small (1998).

2 See Severen (2019) for details of this hybrid method.

3 See Heblich, Redding, and Sturm (2018) and You (2017).

4 See Bailey et al. (2019).

5 Economists call the general phenomenon of increased productivity in or near large collections of people or firms agglomeration. See Chatman and Noland (2014).

6 See Duranton and Puga (2004) and Rosenthal and Strange (2004).

7 On average, and across cities worldwide, subways appear to have an insignificant impact on overall population growth, though they lead to more concentrated cities than does comparable highway construction. See Gonzalez-Navarro and Turner (2018).

8 See Black, Kolesnikova, and Taylor (2014).

9 Of course, automobiles are also valuable for increasing the mobility of some people with disabilities.

10 See Department of Transportation (2018).

11 See Davis, Williams, and Boundy (2016).

12 See Duranton and Turner (2018).

13 See Mangum (2017).

14 See Bowes and Ihlanfeldt (2001).

15 See Brinkman and Lin (2019).

16 See, for example, Billings (2011) and Chen and Whalley (2012).

17 See, for example, Allen and Arkolakis (2019) and Tsivanidis (2018).

18 Spatially detailed data on commuting behavior is available only for 1990 and 2000, and since 2002.

19 It was operated as three lines at the time; one line had two branches. These are now operated as two lines.

20 There were also unique factors that arose during the planning and construction of Los Angeles Metro Rail that help clearly differentiate the direct effects of Los Angeles Metro Rail from other factors that could influence neighborhood change. These factors argue for interpreting the estimates described below as causal (rather than simply correlative). See Severen (2019) for a description of an exploding clothing store and more discussion.

21 Census tracts have on average 4,000 residents, though size can vary quite a bit. There are about 2,400 census tracts in the area under study, implying approximately $2{,}400^2$=5.76 million pairs of residential-workplace connections.

22 This is accomplished by using neighborhood-by-year fixed effects.

23 Red Cars (the Pacific Electric Railroad's Los Angeles streetcar system) were a notable component of commuting in Los Angeles prior to WWII. The last Red Car ran in 1961.

24 Neighborhoods that first became connected between 2002 and 2015 experienced a 9 to 13 percent increase.

25 This is between one-third and one-quarter the size of the short-run effect Anderson found in his 2014 paper. He used the Los Angeles Metro Rail labor strike of 2003 to provide very high-quality evidence that the presence of rail service reduced congestion (as measured by vehicle speed) along Los Angeles freeways by up to 12 percent. The difference in findings is most likely due to the time frame: I study changes in congestion after years have passed, while Anderson focused on travel during an event that lasted about five weeks.

26 Because of data limitations, I only studied noncommuting outcomes between 1990 and 2000 (rather than extending the analysis to 2015, as I do for commuting).

27 See Brinkman and Lin (2019).

28 A similar approach works with housing prices, with one small adjustment: We must account for the fact that people spend only part (typically about one-third) of their income on housing. So if a 10 percent reduction in housing prices in a neighborhood (holding other characteristics of the neighborhood constant) induces 18% × (⅓) = 6% more people to live in a neighborhood, then a 6 percent increase in commuting from that location is equivalent to a 10 percent reduction in housing prices.

29 Economists call these variables shift-share or Bartik instrumental variables. Because of the particular setting and data in my 2019 working paper, many critiques of this approach are not relevant here.

30 Economists often consider other externalities, sometimes called spillovers, in these models. A typical externality is agglomeration. Though I discuss this in my working paper, I do not discuss it here.

31 The increased commuting between 2002 and 2015 could be attributed to either the slow adjustment of people to Los Angeles Metro Rail or the growth of the network and increased service area after 2002. The $216 million annual benefit attributes all the growth to slow adjustment (and can therefore use the same cost basis as the $109–$146 million annual benefit estimate).

32 For example, Nicolas Gendron-Carrier and his coauthors found that subways decrease air pollution. Applying their estimates and methods to Los Angeles suggests that Los Angeles Metro Rail may have up to an additional $180 million in annual benefits (roughly equal to the commuting benefit). Accounting for this brings total benefits within the lower end of the cost range. However, it is not obvious that these benefits represent a long-run gain, as decreased congestion from rail transit could eventually induce more driving (and thus more pollution).

33 All dollar amounts have been inflation-adjusted to their 2015 equivalents. Figures are author's calculations based on LACMTA fiscal year budget filing reports.

34 The range captures the wide variety of assumptions used to value the benefits of infrastructure projects.

35 There exists little detailed work comparing costs internationally, but Alon Levy has created perhaps the most exhaustive dataset at his blog, Pedestrian Observations. Brooks and Liscow (2019) showed that the costs of other transportation infrastructure in the U.S. (specifically, highways) started to increase substantially in the late 1970s.

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Central Bank Digital Currency

Is It a Good Idea?

A CBDC might make banking easier for you and me. It might also change how banks operate.

BY DANIEL SANCHES

Thanks to recent technological advances, central banks can issue a new type of money that travels through a network of computers around the globe and is exchanged with the click of a mouse or by using a mobile device. This central bank digital currency (CBDC) could change how people make payments and how financial firms operate. A CBDC is an efficient payment instrument for both domestic and international transactions, but it might prompt households and firms to shift funds away from bank deposits, increasing banks' funding cost and decreasing investment in the economy. This article examines a CBDC's potential benefits and trade-offs for society.

Types of Money

In modern economies, a central bank such as the Federal Reserve issues two types of money: physical currency and reserves. Physical currency is the paper notes, such as the dollar bills, that most people use in their daily transactions. Reserves are a unit of account denominated in the country's own currency but issued only to select financial institutions, which can hold the reserves in accounts with the central bank.

Many central banks already issue reserves electronically. If a financial institution has an account with a central bank, it can sell assets (usually government bonds) to the central bank and receive a credit in its central bank account for the value of that transaction. Financial institutions and the central bank rarely use physical currency to settle these large-denomination financial transactions. Instead, they use computers. Thus, reserves are typically a virtual currency issued by the central bank and used for payments within a network of financial institutions. When a financial institution needs to make a payment to another financial institution, it usually transfers the amount electronically from its reserves with the central bank to the other institution's reserves.

Physical currency and reserves are both *outside money*–that is, money created outside the private sector. Outside money can be issued by a central bank, or it can take the form of an asset that has an intrinsic value, such as gold or silver. When the central bank buys government bonds from a financial institution, it pays

for them by increasing the reserve balances of that institution, which implies that the supply of outside money in the economy increases.

Inside money, such as bank deposits and checkable mutual fund accounts, is created by financial firms within the private sector. Unlike outside money, inside money is necessarily a claim on some private issuer. For instance, your checking account with a commercial bank is an asset for you but a liability for the bank. If you decide to withdraw the balance in your bank account, the bank must pay out currency. If the bank makes good on its promise to you, you no longer hold a claim on the bank.

If you want to make a payment to someone who holds an account at a different bank, you instruct your bank to transfer the balance in your account to that person's account. This can be done by check, wire transfer, or some other means. At the end of the business day, your bank is required to transfer reserves to the payee's bank for the value of that transaction. Alternatively, you can withdraw cash to make the payment yourself. So, in a typical daily transaction, the bank either pays currency directly to its depositor or transfers reserves to another financial institution. In other words, the bank must reduce its outside money holdings if a depositor makes a payment to someone outside the bank. Ricardo Lagos provides a useful summary of the types of money available to households and firms (Figure 1).

A CBDC is a new form of outside money designed to eventually replace physical currency. Because it is an electronic token, any individual or firm holding CBDC can make payments to all individuals and firms within the CBDC computer network. An important innovation associated with a CBDC is that if the network is sufficiently large, people can transfer balances without a commercial bank. For instance, you could use your CBDC balance to pay for a meal at your favorite restaurant or to order a new refrigerator from an online retailer. Your transaction is immediately settled via a transfer of electronic outside money to the seller.

Additionally, individuals or firms with an account at the central bank can receive interest payments proportional to their balances, so a CBDC account can earn interest just like a money market mutual fund account. In most advanced economies, financial institutions that are eligible to hold an account with the central bank already receive interest payments on their balances. In other words, some financial institutions have access to interest-bearing outside money. A CBDC would allow the central bank to pay interest to individuals and nonfinancial firms, too.

Initially, the central bank would issue a CBDC and stand ready to exchange it one-for-one with physical currency, which would be necessary to ensure that people and firms feel comfortable with the new payment instrument. Gradually, the central bank would retire physical currency from circulation until it is phased out.

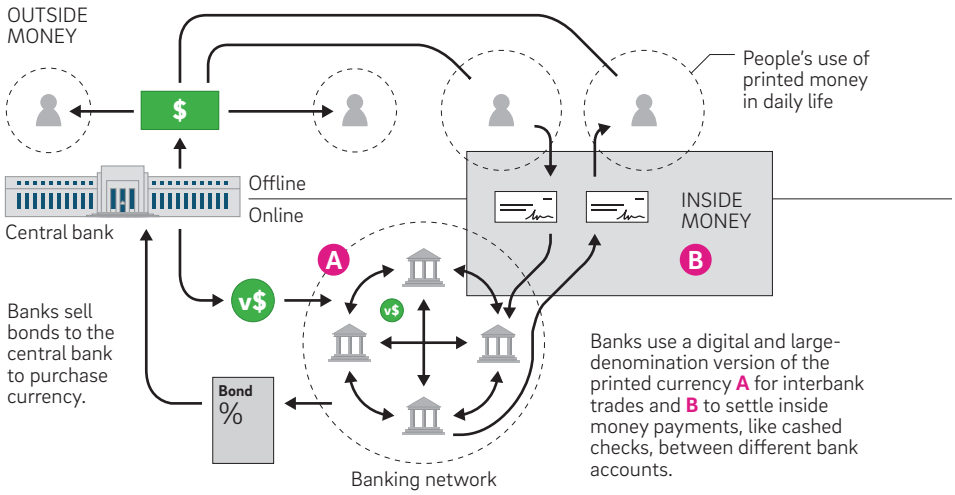
CBDC as an Efficient Medium of Exchange

Consumers typically earn little or no interest on deposit accounts at commercial banks and may pay considerable fees for withdrawing cash from automated teller machines. Merchants pay substantial interchange fees for taking payments via debit and credit cards. These fees reflect both operational costs and profit margins for card-issuing financial firms.

A central bank could offer a CBDC at no cost to households and firms, which could then earn interest on the balances they hold at the central bank. Although the central bank would bear the nonnegligible costs of maintaining the digital transaction records, it might find it worthwhile to subsidize CBDC accounts, as they could serve as a valuable public good.[1]

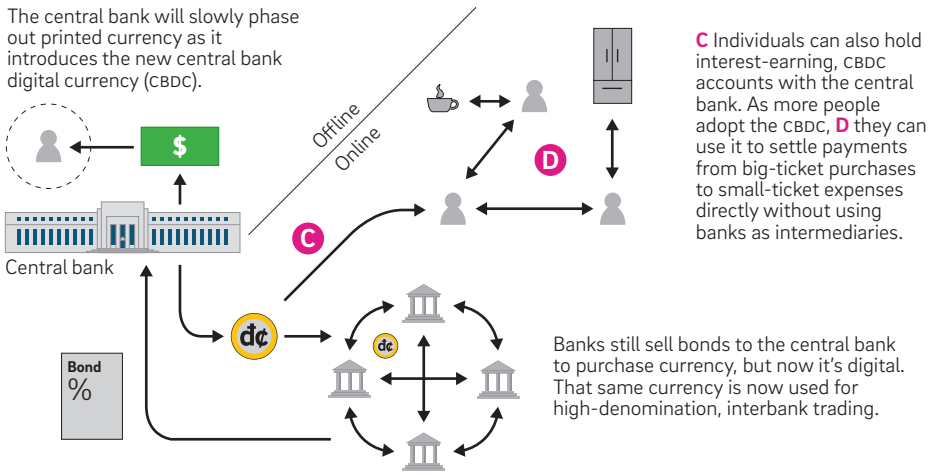
FIGURE 1

With a Printed Currency: Outside vs. Inside Money



But with a Digital Currency...

The central bank will slowly phase out printed currency as it introduces the new central bank digital currency (CBDC).



If a CBDC paid an interest rate in line with other risk-free assets, it could serve as an efficient payment instrument for all sorts of transactions.[2] A big reason why people hold bank deposits and other checkable accounts at financial institutions (even though they pay little or no interest) is because they make it easy for households and firms to make payments. Although consumers value these transaction services, they tend to economize on currency and bank deposits in their portfolio because there is an *opportunity cost* of holding money balances. That cost is the difference between the interest rate on a risk-free asset and the yield on money holdings. An efficient medium of exchange would drive this differential to zero.

When interest rates rise, households and firms tend to transfer some of their wealth from their noninterest-bearing checkable accounts to risk-free assets. By paying an interest rate in line with other risk-free assets in the economy, a CBDC would induce people *not* to transfer money to those risk-free (but illiquid) assets. In his classic 1969 article, Milton Friedman argued that in an economy in which money did not receive a rate of interest, as is now the case, people would hold too little wealth in the form of money. By encouraging people to hold more money as a proportion of their portfolio, a CBDC could make everyone better off.[3]

One advantage of a CBDC is that its network can include all households and firms in each country. By setting the interest rate on a CBDC equal to the risk-free rate, the central bank could then supply an efficient medium of exchange to all agents in the economy.

Another benefit of a CBDC is that it can be a safe asset for households and firms. The current banking system necessitates an elaborate system of bank regulation to prevent bank failures and bank runs. A government bankruptcy is less likely than a banking crisis. Certainly, there is much less probability of a run on a CBDC. As a result, a CBDC can promote financial stability in the banking system.

Disintermediation in the Banking System

As we have seen, a CBDC is a new payment instrument that competes with all forms of inside money. If a central bank decides to launch a CBDC with the previously described properties, some households and firms will likely shift their funds from private financial institutions to an account at the central bank, a process economists call *disintermediation*.

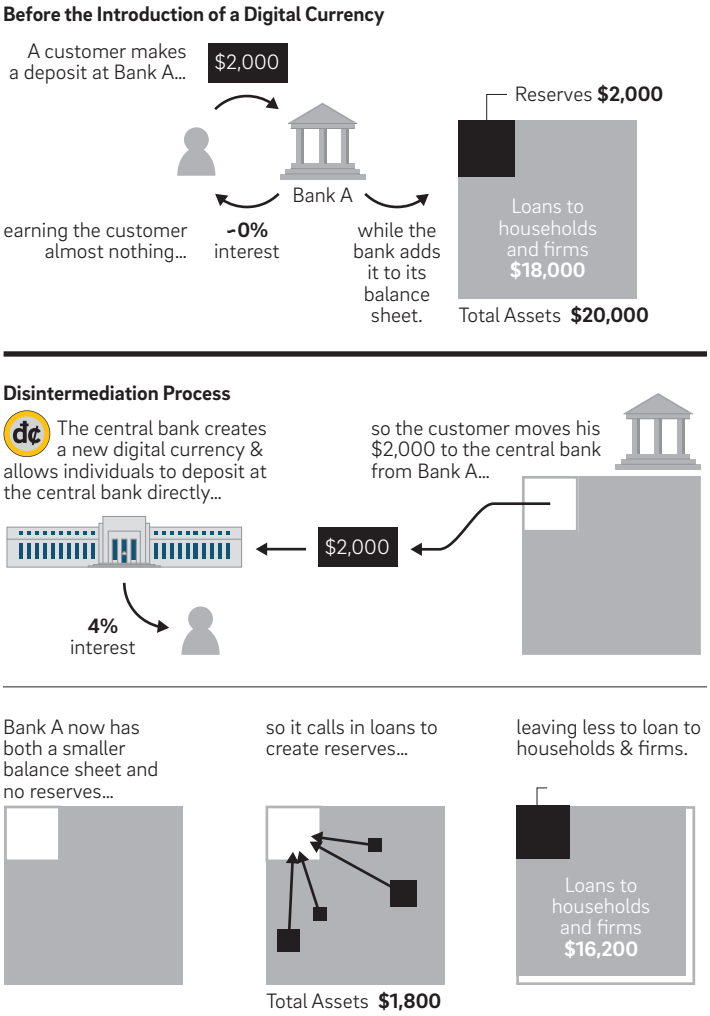
To better understand disintermediation, suppose that a central bank creates a CBDC overnight and offers to pay 4 percent per annum interest on its account balances. Right now, commercial banks in the U.S. offer a negligible, if not zero, interest rate on most retail customers' account balances. If commercial banks do not change their interest rate strategy in response to the introduction of a CBDC, many people and firms will likely transfer their balances to a CBDC account immediately. Because commercial banks issue deposits to finance loans to households and firms, they will have to contract their loan portfolio in response to a decline in deposits, leading to disintermediation in the banking system.

The exact amount of this disintermediation depends on many factors. For example, suppose that someone with a private-bank account worth $2,000 decides to shift their balance to the newly created CBDC. The private bank's deposits—and its reserves with the central bank—decline by $2,000. On the liability side of the central bank's balance sheet, reserves diminish by $2,000 and the CBDC rises by the same amount.

Now suppose that the private bank initially had $20,000 worth of assets, with $2,000 in reserves held in an account with the central bank and $18,000 in loans to firms and households. In other words, the private bank held 10 percent of its assets in reserves. After one of its depositors transfers $2,000 to the CBDC, the private bank ends up with no reserves at all. To return to the desired portfolio composition, it would have to call in $1,800 worth of loans, holding everything else constant (Figure 2). But this would happen only if the central bank does not issue new units of the CBDC to buy assets from the private bank.

This example shows that the amount of loans generated from within the private sector will likely contract upon the introduction of a CBDC that pays a sufficiently attractive interest rate. If households and firms shift their funds to a CBDC, and if nothing else changes in the economy, intermediaries in the financial system must contract their balance sheets, which is why the creation of a CBDC can lead to a reduction in private-bank loans to households and firms.

FIGURE 2



Under normal conditions, central banks, unlike commercial banks and other private intermediaries, do not provide intermediation services—that is, they do not provide funding for private firms and households. Instead, the central bank typically just issues currency or reserves to buy short-term government securities. Although many central banks still hold other types of assets on their balance sheets as a legacy of the policy response to the 2007-2008 global financial crisis, most central banks say they will soon return to normal operational procedures.

However, a central bank could invest the funds it raises by issuing a CBDC in other assets, such as corporate bonds and mortgage-backed securities. In this case, disintermediation does not necessarily reduce the supply of credit in the economy.

This discussion shows that the effects of a CBDC on credit allocation, production, and consumption can vary depending on how the central bank behaves when launching a CBDC. Recent research examines the effects of a CBDC when the central bank sticks to its standard operational procedures, and when it instead engages in private intermediation following the creation of a CBDC.

CBDC Without Central Bank Intermediation

Todd Keister[4] and I have studied the effects of the introduction of a CBDC in the context of a formal economic model. Throughout the analysis, we assume that the central bank follows the standard procedure of buying government bonds when it expands the supply of CBDC and selling government bonds when it contracts the supply. But we do not assume that the central bank is necessarily backing all of the CBDC supply with government bonds. For instance, the central bank could finance some of the CBDC interest payments by simply issuing more units of the CBDC. Finally, we assume it doesn't cost much for the central bank to issue a CBDC.

We then consider all effects associated with the introduction of a CBDC, including the reaction of private banks. We find that although a CBDC promotes efficient exchange, it crowds out private-bank deposits, raises private-banks' funding cost, and decreases investment. We show that despite these effects, a CBDC raises the welfare of households in the economy under certain conditions.

Once it introduces a CBDC, the central bank might raise the interest rate paid on balances held at the central bank to promote efficient exchange. As we have seen, the private banking system currently offers an interest rate on deposits lower than the interest rate on risk-free assets, which leads to inefficient exchange. Thus, in our analysis, the introduction of a CBDC is necessarily associated with a higher interest rate on CBDC balances than the interest rate on deposits prior to the introduction of a CBDC, given that the central bank's goal is to create a CBDC that provides an efficient medium of exchange to households and firms. To avoid losing funds to the central bank, private financial firms will likely then raise the interest rate on their deposits, too. A higher interest rate on deposits means a higher funding cost for private banks, which will likely charge more for their loans to borrowers.

Taking the costs of disintermediation into account, we find that households will, nonetheless, often benefit from the introduction of a CBDC. The benefits of introducing an efficient medium of exchange more than offset the increase in private banks' funding cost and associated decline in investment, resulting in larger output for the whole economy.

This is true when *investment frictions* are relatively small. Investment frictions take many forms. For example, borrowers may know more than the private bank about their future risks or actual revenues, so banks bear added costs to ensure repayment of the loan. Or, as in our model, private banks may be unable to capture a large enough share of the borrower's project payoffs.[5] Whatever the cause, investment frictions lead the private bank to demand a higher interest rate as compensation than would be required in the absence of frictions. Meanwhile, the bank will refuse to make some loans that would be profitable in the absence of investment frictions.

To maintain their spreads as their funding cost rises, private banks raise the interest rate they charge for loans, increasing the number of profitable projects they can no longer fund.[6] These profitable projects that are no longer funded—that is, projects that would have been funded despite the investment frictions—are the social cost of disintermediation.

For example, consider a local bank that accepts deposits from households and then loans some of that money to small businesses. Assume that all borrowers are equally likely to default. Finally, assume that the bank pays households 1 percent per annum on their deposits and charges borrowers 5 percent per annum on their loans. In this case, the bank spread is 4 percent, which generates earnings to cover the bank's operational costs and create a profit margin for the bank's owners. If the bank's funding cost increases to 2 percent as a result of the introduction of a CBDC that pays an interest rate of 2 percent per annum, then the bank will end up charging borrowers 6 percent on their loans to maintain a bank spread of 4 percent. Consequently, all projects that earned a rate of return for the borrower of between 5 and 6 percent per annum are no longer profitable for the borrower, so those borrowers will no longer apply for these loans. Assuming that they have no other ready source of funds, these projects will not get done.

We assume that investment frictions are relatively small, so we expect to see a relatively small decline in the supply of loans following an increase in the private bank's funding cost. Because we also calculate, upon the introduction of a CBDC, large benefits from this more efficient medium of exchange, we conclude that a CBDC benefits society. Although it can lead to disintermediation, a CBDC is worthwhile.

CBDC with Central Bank Intermediation

In a recently published paper, Markus Brunnermeier and Dirk Niepelt identified the conditions under which a shift of funds from private-bank deposits to a CBDC does not change the aggregate portfolio of loans and securities for the whole economy. The authors allow the bank to engage in private financial intermediation when issuing a CBDC. For instance, the central bank could issue a CBDC to buy privately issued loans, such as mortgages and commercial loans, from private financial institutions if doing so is part of its intervention strategy.

Their analysis assumes that the central bank and private-sector financial institutions are equally adept at identifying investment opportunities and monitoring loans, which is unlikely in the real world. They found that the introduction of a CBDC might not crowd out the supply of loans to firms and households, which they would use to finance private investment, if the central bank is willing to engage in private financial intermediation.

Jesus Fernandez-Villaverde, Linda Schilling, Harald Uhlig, and I have considered a framework in which the central bank, unlike private financial institutions, cannot identify investment opportunities and monitor loans. We believe this is a better approximation of the real world, given that both investment and commercial banks invest considerably in the selection, screening, and monitoring of their borrowers, which requires both sophisticated software and highly qualified analysts.

Surprisingly, we found that even though the central bank can't identify all investment opportunities, it can introduce a CBDC without disintermediation. If the central bank is willing to engage in private financial intermediation when issuing a CBDC, it can redeposit part of the funds raised from CBDC depositors with investment banks. These banks can identify profitable long-term investment opportunities, which will provide the central bank with revenue to finance the interest payments on a CBDC. The result is that the supply of loans in the economy does not change following the creation of a CBDC.

However, this does not account for the benefits of a socially efficient medium of exchange. These analyses focused on the role of banks as providers of intermediation services, and the conditions under which a CBDC, when combined with changes in the central bank's operational procedures, does not crowd out private investment. We did not examine the role of banks as providers of liquidity services through demand deposit accounts that are used as a medium of exchange.

As we have seen, commercial banks pay negligible if any interest on checking accounts, and high-yielding accounts offered by investment banks are not always checkable. The Keister–Sanches study, on the other hand, considered the benefits of a CBDC designed to serve as an efficient medium of exchange, even if it shifts the supply of credit because the central bank does not engage in financial intermediation.

Conclusions

Central banks are investigating a CBDC's benefits and trade-offs for society. Although a CBDC can crowd out private-bank deposits and increase private banks' funding cost, it can also promote efficient exchange and improve the allocation of resources in the economy. Although the initial set of papers analyzing the effects of a CBDC focused on some key elements, there are many other aspects of the monetary system that require additional research, such as the impact of a CBDC on the framework for the implementation of interest-rate policy for business-cycle adjustments.

As we have seen, discussions of the merits of a CBDC have led economists to rethink the central bank's role in the provision of liquidity and intermediation services. The rise of new technologies and competition from the private sector will likely result in a fundamental change in central banking. Many scholars, including myself, think that this will be the greatest debate of our time in the field of money and banking.

Notes

1 Michael Bordo and Andrew Levin have argued that a CBDC could be implemented via accounts held directly at the central bank or via specially designated accounts at supervised commercial banks, which would hold the corresponding amount of funds in segregated reserve accounts at the central bank.

2 A risk-free asset is a security that has a certain future return. For instance, Treasury securities are considered a risk-free asset because the U.S. government guarantees all future payments.

3 See my 2012 *Business Review* article for a detailed discussion of the properties of efficient media of exchange.

4 Todd Keister is a professor of economics at Rutgers University. Previously, he was an assistant vice president at the Federal Reserve Bank of New York.

5 In the contracting literature, some project payoffs may be nonpledgeable for a number of reasons. For example, to keep a manager of a firm properly motivated, the manager may need to receive a sufficiently high compensation. But this means the firm can't pledge the manager's future compensation to the bank.

6 The spread is the difference between how much interest a bank pays to its depositors–also known as its funding cost–and how much interest it collects from its borrowers.

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House Price Booms, Then and Now

House prices rose rapidly in the run-up to the crash of 2007, but not everywhere. Understanding why can help us prepare for future recessions.

BY BURCU EYIGUNGOR

House prices boomed in the early 2000s, but not everywhere. Many places experienced only mild price increases.

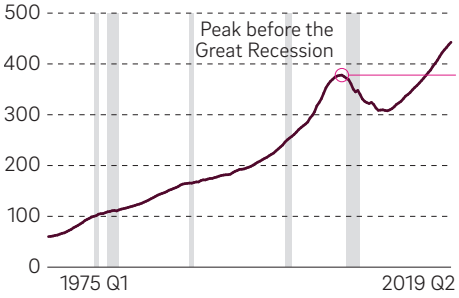
Economists have two explanations for this diversity in the increase in house prices across locations. One is that demand increased everywhere, but prices increased more where supply could not easily expand. I call this the aggregate demand view. In the second explanation, demand increased more in densely settled areas where additional construction was difficult. As more people wanted to live in those locations, aggregate house prices rose. I call this the reallocation view.

I explore the evidence for both views. Although both mechanisms probably contributed to this diversity of house prices during the boom, one was likely dominant. Understanding which was dominant is especially important now, as prices have risen again. The Federal Housing Finance Agency's (FHFA's) all-transactions house price index has passed its previous peak, and, when discounted by the GDP deflator, the index is very close to the previous peak in real terms, too (Figures 1-2). The previous house price increase was followed by a large bust leading to the Great Recession. Are we risking another house price bust today?

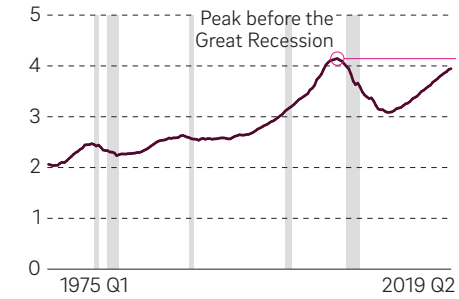
FIGURES 1 AND 2

The House Price Index Has Passed Its Peak and Almost Equals It When Deflated

U.S. FHFA All-Transactions House Price Index



Deflated FHFA All-Transactions House Price Index



Note: House Price Index is deflated by GDP Implicit Price Deflator. Grey bars represent recessions.

Sources: FHFA/Haver Analytics.

Two Views on the Aggregate House Price Boom

According to the aggregate demand view, the demand for housing increased roughly similarly across locations, which led to the house price boom.

An increased desire for homeownership may have directly boosted demand. As more people want to buy homes, consumption of housing typically increases. Or something indirect may have increased demand. Low interest rates or a relaxation of borrowing constraints could have made homeownership more accessible, leading to more demand for housing.

Regardless of cause, a demand shock would have spurred households to want to consume more housing everywhere, but prices would have increased even more where supply could not expand easily (that is, where there was low supply elasticity). In these locations, higher prices would have prevented locals from consuming more housing and nonlocals from moving in.

Several economists embrace this view and have searched for an aggregate shock that could have led to the aggregate house price increase. Either their models do not differentiate by geography,[1] or they use different house supply constraints across space to predict the differential house price growth.[2] Either way, these economists assume that places with more stringent house supply restrictions were no more attractive to live in during the boom.

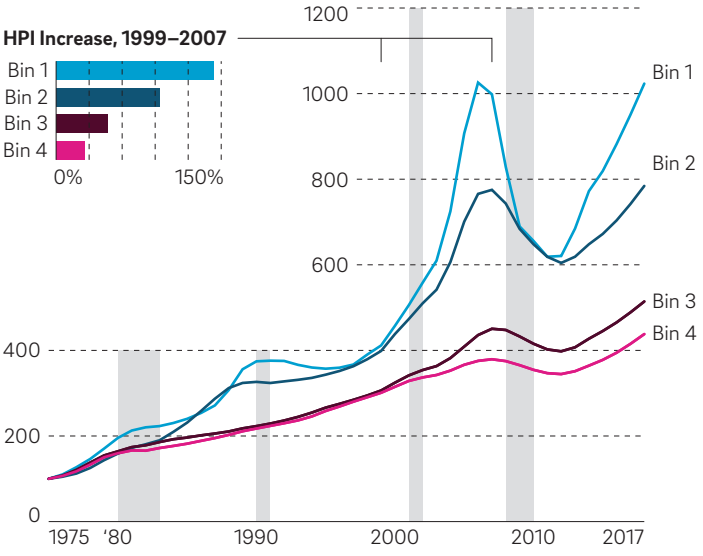
But according to the reallocation view, a reallocation shock made some locations more attractive than others. For this to lead to higher *aggregate* house prices, people must have wanted to move from less-dense areas (where housing could be created cheaply) to areas where housing could not easily expand.[3]

Economists who embrace the reallocation view posit several reasons why denser locations might have become more appealing. For example, the service sector, which has supplanted the industrial sector in many parts of the country, benefits from a density of population and requires less land than factories do.

FIGURE 3

House Prices Increased More in Some Bins

In 2000s, house price growth was concentrated in top two bins.



Source: FHFA.

Also, innovators benefit from proximity to other innovators. Indeed, the rate of invention goes up with urban density.[4]

These views beget different policies. If the demand increase for housing is similar across locations, federal policymakers may want to diminish the magnitude of the boom-bust cycle through regulation or monetary policy. Doing so would lower the cost of a recession that might follow a large house price boom. But if aggregate house prices rise because of reallocation, then federal policymakers might not be able to stabilize house prices through regulation or monetary policy. Instead, it would be up to local governments to increase the housing supply and stabilize house price increases by relaxing zoning and building restrictions.

Analyzing the Two Views

To analyze the relative importance of each view, I rank locations according to their house price increase from 1999 to 2007. I split locations into four separate bins, with each bin having a roughly equal share of employment in 1999. Throughout the analysis, the first (or top) bin saw the highest house price growth, the second bin the second-highest house price growth, and so on.

There was a substantial house price increase during the early 2000s in the top two bins, but the increase was mild for the bottom two bins (Figure 3). House prices in the first bin, which had the highest house price increase during the early 2000s, are once again booming, so maybe there is something different about these locations—something that gives them more pronounced boom-bust cycles.[5]

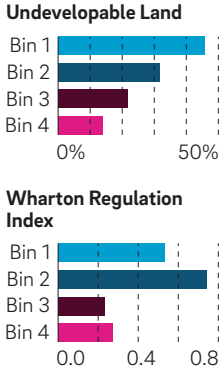
House supply elasticity varies across locations, and this plays a crucial role in both views. If aggregate demand increases, people everywhere would like to consume more housing, but if housing cannot expand in one location, house prices rise more in that location. This dissuades locals from consuming more housing or nonlocals from moving in. But if reallocation leads to higher aggregate prices, people should be moving into higher-priced locations where housing cannot expand easily. In both views, prices increase more where housing cannot easily expand, but for different reasons.

Economists have two ways to assess how hard it is to expand housing. One is the Wharton Regulation Index (WRI), which measures the regulatory hurdles new development faces in different locations. The other, the Saiz measure, documents the share of undevelopable land in the most populous 100 metropolitan areas.[6] Figure 4 displays the average WRI and Saiz measure for all four bins. (Each location is weighted by its employment in 1999.) Consistent with both views, constructing new housing is hardest in the top two bins, which had the highest price increases.

FIGURE 4

More Barriers to Development

Two measures show it was harder to expand housing in markets that saw highest increase in home prices.



Source: Saiz (2010); University of Pennsylvania.

Relative Housing Demand

One way to distinguish between the two views is by looking at the correlation between house price growth and employment growth during the house price boom of 1999-2007. If an aggregate demand shock was dominant, places with higher house price growth should have experienced lower employment growth—that is, the correlation between house price growth and employment growth across locations should have been negative. This is because where supply cannot expand easily, house prices rise more and employment growth suffers. But if the reallocation forces are strong enough, then we would see that places with higher house price growth also have higher employment growth (that is, a positive correlation). In spite of higher house price increases, the demand increase is so much stronger in these locations that employment growth is higher as well.

To assess whether a location had strong employment growth, it helps to know its initial employment. Employment in big cities, which have less developable land, might not be able to grow as fast as in small cities. Three percent employment growth in a year might be very strong for a big city but unexceptional for a small city.

This is why Figure 5 shows the logarithm of initial employment in 1999 on the x-axis and employment growth between 1999 and 2007 on the y-axis. Blue dots denote locations in the top two bins with the highest house price growth. Red dots denote locations in the bottom two bins with the lowest house price growth. Each dot represents the average of 20 locations. All the blue dots are above the red dots, which means that, on average, places with higher house price growth also had higher employment growth. This indicates that reallocation was dominant during this period.[7]

Reallocation was strongly at play during the boom years, but how does this compare to other periods? To find out, I look at how employment has evolved across the different bins. Employment grew faster in the first bin: From 1969, the first year data are available, to 1995, employment in the first bin grew at an annual rate of 2.9 percent; from 1995 to 2007, it grew at 2.4 percent. In other words, we do not see an acceleration in the growth of employment in the first bin during the period with higher aggregate house price growth (Figure 6).

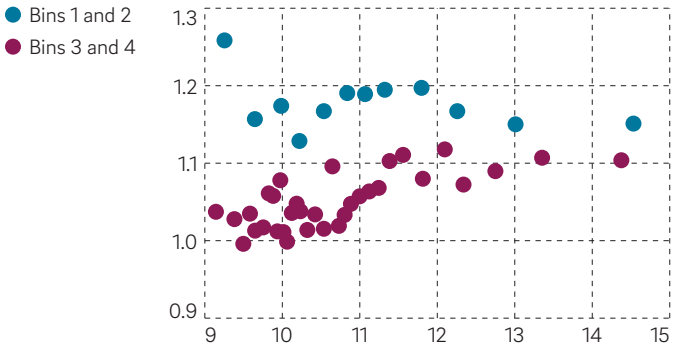
To clearly show the relative growth of the top bin, Figure 7 divides the average employment of the cities in each bin by the average employment in the fourth bin. We see that the top bin was composed of bigger cities overall, and it has grown faster relative to the bottom bin during the sample period. Again, we do not see an acceleration of this relative growth after 1995 (when real aggregate house price growth increased).

My analysis of the data leaves us with a mixed conclusion. Yes, there has been an ongoing reallocation across locations, and more desirable locations in the first bin have had faster employment and faster house price growth for a long time. But reallocation does not seem to have accelerated during the early 2000s, so it is at best an incomplete cause of that era's large price boom. Given that we are not able to settle the debate on what caused the steep increase in house prices during the 2000s and why it is happening again, we should keep an eye on risk factors that might lead to excessive risk-taking, exacerbating the boom-bust episodes.

FIGURE 5

Employment Grows Strongly in Top Two Bins

Logarithm of initial employment, 1999, on x-axis; employment growth, 1999–2007, on y-axis; each dot equals average of 20 locations

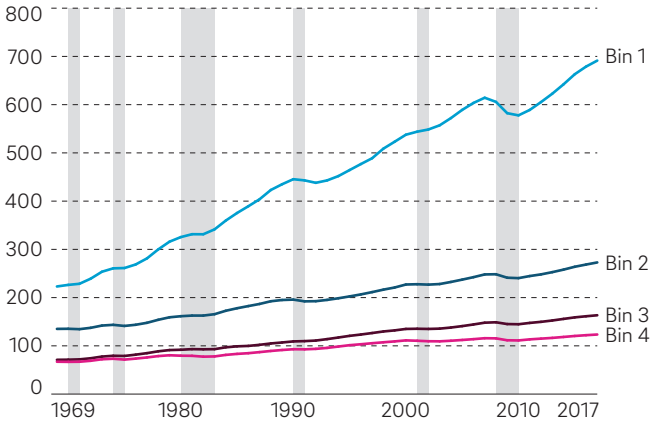


Source: FHFA and U.S. Bureau of Economic Analysis (BEA).

FIGURE 6

Employment Grows Most in First Bin...

Average employment in cities, thousands, 1969–2017

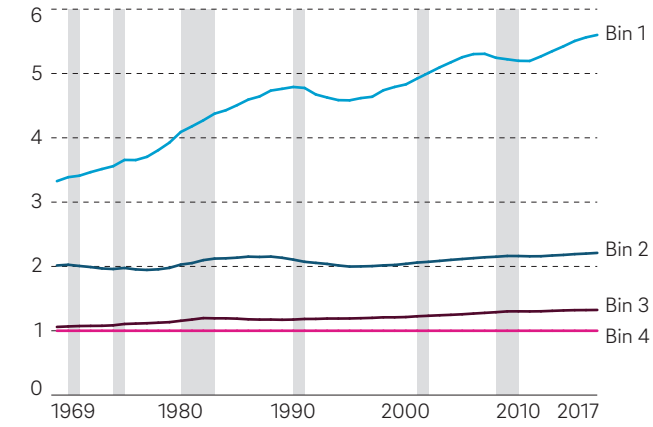


Source: BEA.

FIGURE 7

... Even When Normalized

Average employment in cities, thousands, 1969-2017, normalized by fourth bin

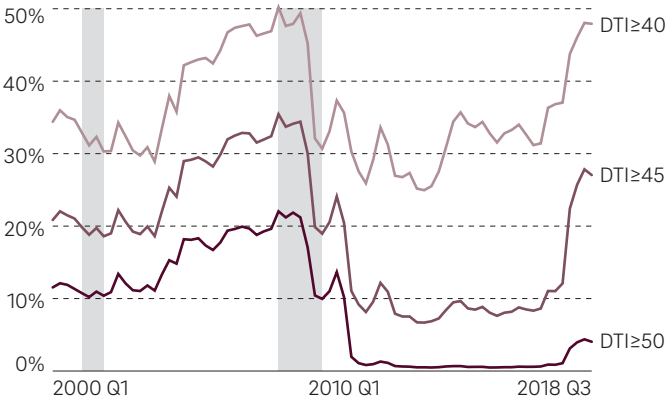


Source: BEA.

FIGURE 8

Higher-Risk Mortgages Spike After Rules Loosened

DTI ratio of 30-year fixed mortgages at origination, 2000–2018



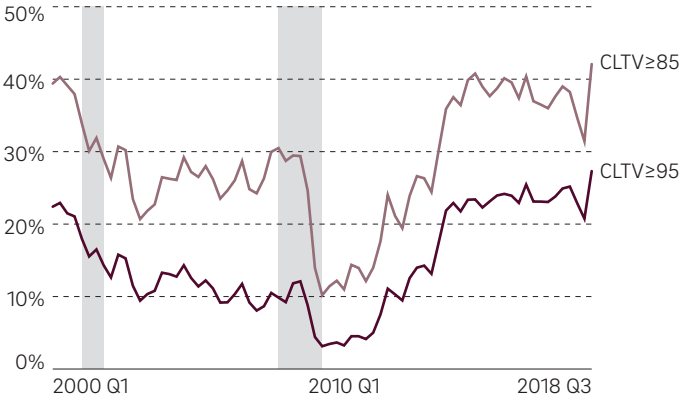
Source: Fannie Mae loan performance data.

FIGURE 9

Riskier Loans Rise

After FHFA directed GSEs to increase maximum LTV, share of riskier mortgages gradually increased.

Combined LTV ratio of 30-year fixed mortgages at origination, excl. refinance loans



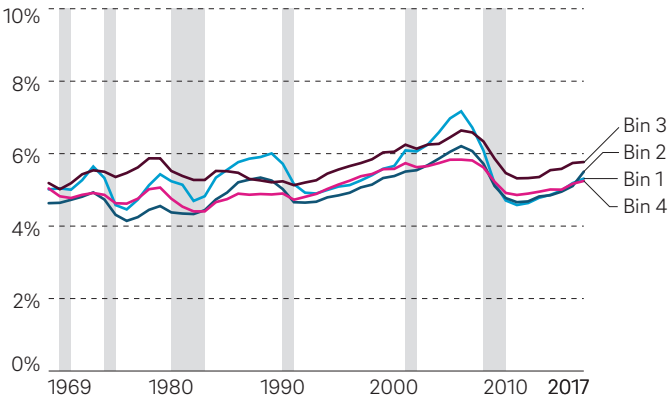
Source: Fannie Mae loan performance data.

FIGURE 10

Only a Mild Increase in Construction Employment

Construction share of employment increased sharply during the early 2000s, mildly since 2012.

House price growth and construction share in employment, 1969–2017



Source: BEA.

Risk Factors Facing the Economy

Three macroeconomic variables may have contributed to the boom and bust of the 2000s: looser borrowing constraints, a construction boom, and backward-looking credit scoring.

During (especially long-lasting) booms, risks may be forgotten and creditors might relax borrowing constraints. When a recession hits, creditors reinstate those constraints, exacerbating the bust.

To measure the effect of looser borrowing constraints, I focus on loans acquired by government-sponsored enterprise (GSE) Fannie Mae. Fannie Mae acquires only conforming mortgages. To conform, the mortgage must not exceed the maximum debt-service-to-income (DTI) ratio and the maximum loan-to-value (LTV) ratio.

The loosening of the DTI constraint may have led to the housing boom.[8] Prior to 2008, GSEs Fannie Mae and Freddie Mac purchased mortgages with DTI ratios up to 65 percent. In early 2010, when loose lending standards were blamed for the high mortgage default rates after the recession hit, the GSEs reduced the DTI limit to 50 percent. Fannie Mae imposed additional credit score requirements for mortgages with a DTI ratio between 45 and 50 percent.

Those constraints have recently been loosened. In April 2017 the FHFA eliminated additional requirements for mortgages up to 50 percent DTI. The rule change had an immediate effect on Fannie Mae mortgages: The percentage of 30-year fixed-rate mortgages that originated with a DTI ratio greater than or equal to 45 percent rose from 8.6 percent in the fourth quarter of 2016 to 27 percent in the third quarter of 2018 (Figure 8).

Meanwhile, in 2015, the FHFA directed the GSEs to increase the maximum LTV from 95 percent to 97 percent. In response, the share of 30-year fixed-rate mortgages with an LTV ratio greater than 95 percent gradually increased to its highest level since 2000. Today these mortgages constitute around 25 percent of the loans at origination (Figure 9). This gradual increase began in 2011, around the time that house prices began their rise.

Although these numbers indicate that there is increasing risk in the market for conforming loans, loans with a DTI ratio greater than 50 percent are far less common today than they were before the Great Recession, and many of the highly risky nonconforming mortgages—such as balloon loans and no-interest loans—no longer exist.

A second risk factor is a construction boom. Some economists argue that the construction boom of the early 2000s created an excess supply of housing, which led to the subsequent house price crash.[9]

Whereas the construction share of employment increased sharply during the early 2000s, the increase since 2012 has been mild (Figure 10). This might be good news: If the economy slows down, house prices may decline less than they did in the 2000s. (The bad news: House prices may have been rising recently because not enough housing was being built.)

Backward-looking credit scoring, when combined with a swing in bankruptcy rates, is a third risk factor that may magnify boom-bust cycles.

Figure 11 shows the bankruptcy rate for the different bins. A 2005 change in bankruptcy law led to a large increase in bankruptcy filings. (That is, many people rushed to file in 2005

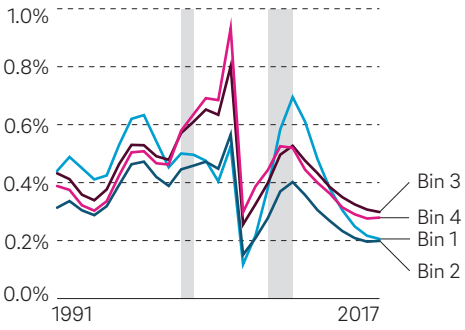
before the change took effect.) Other than this spike, the bankruptcy rate fell fast in the first bin during the house price boom: Before 1999, the first bin had the highest bankruptcy rate; between 1999 and 2006, it had the lowest.

FIGURE 11

Bankruptcy Rate Fell Fast

First bin had highest bankruptcy rate before 1999, lowest 1999–2006.

Bankruptcy rate, 1991–2017



Source: BEA.

There are three reasons why rising house prices might lead to a drop in the bankruptcy rate. First, households can dip into their rising housing equity to pay back their obligations. Second, households don't want to risk losing their homes–and their rising equity–in bankruptcy. And third, the housing boom might lead to a stronger local employment market and thus higher incomes for households.

Regardless of the cause of this lower bankruptcy rate, backward-looking credit scoring in the first bin would have led to higher credit scores for those households and possibly looser credit constraints.

During the recession that started in 2007, places that had previously seen the largest increase in house prices and lowest bankruptcy rate now had the largest decline in house prices and the highest bankruptcy rate. Although the households in the first bin would have had the highest credit scores during the boom (in backward-looking credit scoring), they were in fact the riskiest borrowers when future risks are taken into account. Rising credit scores for these bankruptcy-prone households may thus exacerbate boom-bust cycles by making it too easy for them to get credit.

Conclusion

The second house price boom within two decades shows that the 2000 boom was not a one-off event. However, the current cycle may be different. Although real house prices are very close to their previous peak, construction growth is mild, and we're not seeing a return of the riskiest type of mortgages, so the house price decline in the next recession (which may now be upon us) might be milder than during the Great Recession. Nonetheless, discovering why house price cycles have become more pronounced in the last two decades should help us prevent a large bust from following future booms.

Notes

1 See Favilukis et al. (2017), Garriga et al. (2019), Greenwald (2018), He et al. (2015), and Justiniano et al. (2019).

2 See Mian et al. (2013) and Mian and Sufi (2014).

3 See Gyourko et al. (2013), Davidoff (2016), and Howard and Liebersohn (2019a, 2019b).

4 See Carlino et al. (2007).

5 The first bin's most populous locations are these metropolitan statistical areas: Los Angeles-Long Beach-Anaheim (CA), Washington-Arlington-Alexandria (DC-VA-MD-WV), San Francisco-Oakland-Hayward (CA), and Miami-Fort Lauderdale-West Palm Beach (FL).

6 See Saiz (2010).

7 Indeed, some of the cities in the first bin have had quite large employment growth. For example, between 1999 and 2007 employment in Las Vegas-Henderson-Paradise (NV), Phoenix-Mesa-Scottsdale (AZ), and Riverside-San Bernardino-Ontario (CA) grew more than 30 percent while housing supply expanded and house prices rose.

8 See Greenwald (2018).

9 See McNulty (2009).

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Research Update

These papers by Philadelphia Fed economists, analysts, and visiting scholars represent preliminary research that is being circulated for discussion purposes.

The views expressed in these papers are solely those of the authors and should not be interpreted as reflecting the views of the Federal Reserve Bank of Philadelphia or Federal Reserve System.

From Incurred Loss to Current Expected Credit Loss (CECL): A Forensic Analysis of the Allowance for Loan Losses in Unconditionally Cancelable Credit Card Portfolios

The Current Expected Credit Loss (CECL) framework represents a new approach for calculating the allowance for credit losses. Credit cards are the most common form of revolving consumer credit and are likely to present conceptual and modeling challenges during CECL implementation. We look back at nine years of account-level credit card data, starting with 2008, over a time period encompassing the bulk of the Great Recession as well as several years of economic recovery. We analyze the performance of the CECL framework under plausible assumptions about allocations of future payments to existing credit card loans, a key implementation element. Our analysis focuses on three major themes: defaults, balances, and credit loss. Our analysis indicates that allowances are significantly impacted by specific payment allocation assumptions as well as downturn economic conditions. We also compare projected allowances with realized credit losses and observe a significant divergence resulting from the revolving nature of credit card portfolios. We extend our analysis across segments of the portfolio with different risk profiles. Interestingly, less risky segments of the portfolio are proportionally more impacted by specific payment assumptions and downturn economic conditions. We also analyze the impact of macroeconomic forecast error and find that it can be substantial and can be impacted by CECL implementation design features. Overall, our findings suggest that the effect of the new allowance framework on a specific credit card portfolio will depend critically on its risk profile. Thus, our findings should be interpreted qualitatively, rather than quantitatively. Finally, the goal is to gain a better understanding of the sensitivity of allowances to plausible variations in assumptions about the allocation of future payments to present credit card loans. Thus, we do not offer specific best practice guidance.

Supersedes Working Paper 19-08.

Working Paper 20-09. José J. Canals-Cerdá, Federal Reserve Bank of Philadelphia Supervision, Regulation, and Credit Department.

Expanded GDP for Welfare Measurement in the 21st Century

The information revolution currently underway has changed the economy in ways that are hard to measure using conventional GDP procedures. The information available to consumers has increased dramatically as a result of the Internet and its applications, and new mobile communication devices have greatly increased the speed and reach of its accessibility. An individual now has an unprecedented amount of information on which to base consumption choices, and the "free" nature of the information provided means that the resulting benefits largely bypass GDP and accrue directly to consumers. This disconnect introduces a wedge between the growth in real GDP and the growth in consumer well-being, with the result that a slower rate of growth of the former does not necessarily imply a slower rate of the latter. The conceptual framework for this analysis is developed in a previous paper (Hulten and Nakamura [2018]), which extended the conventional framework of GDP to include a separate technology for consumer decisions based on Lancaster (1966b) and developed the idea of expanded GDP (or EGDP). In this paper, we use this framework to provide a detailed critique of existing GDP- and price-measurement procedures and summarize the existing evidence on the size of the wedge between GDP and EGDP.

Working Paper 20-10. Charles Hulten, University of Maryland, NBER, and Federal Reserve Bank of Philadelphia Research Department Visiting Scholar; Leonard I. Nakamura, Federal Reserve Bank of Philadelphia Research Department Emeritus Economist.

Bargaining Shocks and Aggregate Fluctuations

We argue that social and political risk causes significant aggregate fluctuations by changing bargaining power. To that end, we document significant changes in the capital share after large political events, such as political realignments, modifications in collective bargaining rules, or the end of dictatorships, in a sample of developed and emerging economies. These policy changes are associated with significant fluctuations in output. Using a Bayesian proxy-VAR estimated with U.S. data, we show how distribution shocks cause movements in output and unemployment. To quantify the importance of these political shocks for the U.S. as a whole, we extend an otherwise standard neoclassical growth model. We model political shocks as exogenous changes in the bargaining power of workers in a labor market with search and matching. We calibrate the model to the U.S. corporate nonfinancial business sector and we back out the evolution of the bargaining power of workers over time using a new methodological approach, the partial filter. We show how the estimated shocks agree with the historical narrative evidence. We document that bargaining shocks account for 28 percent of aggregate fluctuations and have a welfare cost of 2.4 percent in consumption units.

Supersedes Working Paper 17-25.

Working Paper 20-11. Thorsten Drautzburg, Federal Reserve Bank of Philadelphia Research Department; Jesús Fernández-Villaverde, University of Pennsylvania and Federal Reserve Bank of Philadelphia Research Department Visiting Scholar; Pablo Guerrón-Quintana, Boston College and Federal Reserve Bank of Philadelphia Research Department Visiting Scholar.

Real Estate Taxes and Home Value: Winners and Losers of TCJA

In this paper, we examine the impact of changes in the federal tax treatment of local property taxes stemming from the implementation of the Tax Cuts and Jobs Act (TCJA) in January 2018 on local housing markets. Using county-level house price information and IRS tax data, we find that capping the federal tax deduction of real estate taxes at $10,000 has caused the growth rate of home values to decline by an annualized 0.8 percentage point, or 15 percent, in areas where real estate taxes as shares of taxable income exceeded the national median. Additionally, these areas with a high real estate tax burden suffered from reductions in market liquidity after the reform. Fewer houses were transacted either in absolute numbers or as shares of total listings, houses stayed on the market longer before being sold, and more houses were listed with price cuts. Importantly, we find that the housing market slowdown was accompanied by declines in local construction employment growth as well as multifamily building permits. Furthermore, on net more people moved out of these areas after the reform. Finally, we show that the act has already had political consequences. In the 2018 midterm Senate elections, more voters voted for Democratic candidates in areas with high real estate tax burden than for Republican candidates.

Working Paper 20-12. Wenli Li, Federal Reserve Bank of Philadelphia Research Department; Edison G. Yu, Federal Reserve Bank of Philadelphia Research Department.

Piecewise-Linear Approximations and Filtering for DSGE Models with Occasionally Binding Constraints

We develop an algorithm to construct approximate decision rules that are piecewise-linear and continuous for DSGE models with an occasionally binding constraint. The functional form of the decision rules allows us to derive a conditionally optimal particle filter (COPF) for the evaluation of the likelihood function that exploits the structure of the solution. We document the accuracy of the likelihood approximation and embed it into a particle Markov chain Monte Carlo algorithm to conduct Bayesian estimation. Compared with a standard bootstrap particle filter, the COPF significantly reduces the persistence of the Markov chain, improves the accuracy of Monte Carlo approximations of posterior moments, and drastically speeds up computations. We use the techniques to estimate a small-scale DSGE model to assess the effects of the government spending portion of the American Recovery and Reinvestment Act in 2009 when interest rates reached the zero lower bound.

Working Paper 20-13. S. Borağan Aruoba, University of Maryland and Federal Reserve Bank of Philadelphia Research Department Visiting Scholar; Pablo Cuba-Borda, Board of Governors of the Federal Reserve System; Kenji Higa-Flores, University of Maryland; Frank Schorfheide, University of Pennsylvania, CEPR, NBER, PIER, and Federal Reserve Bank of Philadelphia Research Department Visiting Scholar; Sergio Villalvazo, University of Pennsylvania.

Responding to COVID-19: A Note

We consider several epidemiological simulations of the COVID-19 pandemic using the textbook SIR model and discuss the basic implications of these results for crafting an adequate response to the ensuing economic crisis. Our simulations are meant to be illustrative of the findings reported in the epidemiological literature using more sophisticated models (e.g., Ferguson et al. [2020]). The key observation we stress is that moderating the epidemiological response of social distancing according to the models may come at a steep price of extending the duration of the pandemic and hence the time these measures need to stay in place to be effective. We caution against ignoring this tradeoff as well as the fact that the timeline of the pandemic remains uncertain at this point. Consistent with the prudent advice of hoping for the best but preparing for the worst, we argue that a comprehensive economic response should address the question of how to safely "hibernate" the national economy for a flexible time period. We provide a discussion of basic policy guidelines and highlight the key policy challenges.

Working Paper 20-14. Lukasz A. Drozd, Federal Reserve Bank of Philadelphia Research Department; Marina M. Tavares, International Monetary Fund.

Important Factors Determining Fintech Loan Default: Evidence from the LendingClub Consumer Platform

This study examines key default determinants of fintech loans, using loan-level data from the LendingClub consumer platform during 2007–2018. We identify a robust set of contractual loan characteristics, borrower characteristics, and macroeconomic variables that are important in determining default. We find an important role of alternative data in determining loan default, even after controlling for the obvious risk characteristics and the local economic factors. The results are robust to different empirical approaches. We also find that homeownership and occupation are important factors in determining default. Lenders, however, are required to demonstrate that these factors do not result in any unfair credit decisions. In addition, we find that personal loans used for medical financing or small-business financing are more risky than other personal loans, holding the same characteristics of the borrowers. Government support through various public-private programs could potentially make funding more accessible to those in need of medical services and small businesses without imposing excessive risk to small peer-to-peer (P2P) investors.

Working Paper 20-15. Christophe Croux, EDHEC Business School; Julapa Jagtiani, Federal Reserve Bank of Philadelphia Supervision, Regulation, and Credit Department; Tarunsai Korivi, Amazon.com; Milos Vulanovic, EDHEC Business School.

Effects of Gentrification on Homeowners: Evidence from a Natural Experiment

A major overhaul of the property tax system in 2013 in the city of Philadelphia has generated significant variations in the amount of property taxes across properties. This exogenous policy shock provides a unique opportunity to identify the causal effects of gentrification, which is often accompanied by increased property values, on homeowners' tax payment behavior and residential mobility. The analysis, based on a difference-in-differences framework, suggests that gentrification leads to a higher risk of delinquency on homeowners' tax bills on average, but there was no sign of a large-scale departure of elderly or long-term homeowners in gentrifying neighborhoods within five years after adoption of the new policy. While tax delinquencies were somewhat inflated by appeals for reassessments, programs designed to provide tax relief for long-term homeowners help mitigate the risk of tax delinquencies and displacement. Findings from this study help researchers, policymakers, and practitioners better understand the mechanisms through which gentrification may impact long-term homeowners and the effectiveness of policies to mitigate these tax burdens and displacement.

Working Paper 20-16. Lei Ding, Federal Reserve Bank of Philadelphia Community Development and Regional Outreach; Jackelyn Hwang, Stanford University and Federal Reserve Bank of San Francisco Community Development Visiting Scholar.

Family Job Search and Wealth: The Added Worker Effect Revisited

We propose and estimate a model of family job search and wealth accumulation with data from the Survey of Income and Program Participation (SIPP). This data set reveals a very asymmetric labor market for household members who share that their job finding is stimulated by their partners' job separation. We uncover a job search-theoretic basis for this added worker effect, which occurs mainly during economic downturns, but also by increased nonemployment transfers. Thus, our analysis shows that the policy goal of increasing nonemployment transfers to support a worker's job search is partially offset by the spouse's cross effect of decreased nonemployment and wages. The added worker effect is robust to having more children and more education in the household and does not just result as a composition of heterogeneous individuals. We also show that the interdependency between household members is understated if wealth and savings are not considered. Finally, we show that gender equality in the labor market not only improves women's labor market performance, but it also increases men's accepted wages and nonemployment rates.

Supersedes Working Paper 16-34.

Working Paper 20-17. J. Ignacio García-Pérez, Universidad Pablo de Olavide and FEDEA; Sílvio Rendon, Federal Reserve Bank of Philadelphia Supervision, Regulation, and Credit Department.

Extended Loan Terms and Auto Loan Default Risk

A salient feature of the $1.2 trillion auto-loan market is the extension of loan maturity terms in recent years. Using a large, national sample of auto loans from the entire auto market, we find that the default rates on six- and seven-year loans are multiple times that of shorter five-year term loans. Most of the default risk difference is due to borrower risks associated with longer-term loans, as those longer-term auto borrowers are more credit and liquidity constrained. We also find borrowers' loan-term choice to be endogenous and that the endogeneity bias is substantial in conventional default model estimates. To mitigate this risk, we separately estimate instrumental variable regression and simultaneous equation models. Finally, we find evidence of adverse selection in borrowers' loan-term choices in the years when six- and seven-year loans first became widely used, which dissipates over time as lenders adjust to risks in the market.

Working Paper 20-18. Xudong An, Federal Reserve Bank of Philadelphia Supervision, Regulation, and Credit Department; Larry Cordell, Federal Reserve Bank of Philadelphia Risk Assessment, Data Analysis, and Research (RADAR) Group; Sharon Tang, Federal Reserve Bank of Philadelphia.

Central Bank Digital Currency: Central Banking for All?

The introduction of a central bank digital currency (CBDC) allows the central bank to engage in large-scale intermediation by competing with private financial intermediaries for deposits. Yet, since a central bank is not an investment expert, it cannot invest in long-term projects itself, but relies on investment banks to do so. We derive an equivalence result that shows that absent a banking panic, the set of allocations achieved with private financial intermediation will also be achieved with a CBDC. During a panic, however, we show that the rigidity of the central bank's contract with the investment banks has the capacity to deter runs. Thus, the central bank is more stable than the commercial banking sector. Depositors internalize this feature ex ante, and the central bank arises as a deposit monopolist, attracting all deposits away from the commercial banking sector. This monopoly might endanger maturity transformation.

Working Paper 20-19. Jesús Fernández-Villaverde, University of Pennsylvania, NBER, CEPR and Federal Reserve Bank of Philadelphia Research Department Visiting Scholar; Daniel Sanches, Federal Reserve Bank of Philadelphia Research Department; Linda Schilling, Ecole Polytechnique, CREST, and CEPR; Harald Uhlig, University of Chicago, CEPR, and NBER.

Partisanship and Fiscal Policy in Economic Unions: Evidence from U.S. States

In economic unions the fiscal authority consists not of one, but of many governments. We analyze whether partisanship of state-level politicians affects federal policies, such as fiscal stimulus in the U.S. Using data from close elections, we find partisan differences in the marginal propensity to spend federal transfers: Republican governors spend less. This partisan difference has tended to increase with measures of polarization. We quantify the aggregate effects in a New Keynesian model of Republican and Democratic states in a monetary union: Lowering partisan differences to levels prevailing during less polarized times increases the transfer multiplier by 0.30. The observed changes in the share of Republican governors lead to variation in the multiplier of 0.20 in the model. Local projection methods support this prediction.

Working Paper 20-20. Gerald Carlino, Federal Reserve Bank of Philadelphia Research Department Emeritus Economist; Thorsten Drautzburg, Federal Reserve Bank of Philadelphia Research Department; Robert Inman, The Wharton School of the University of Pennsylvania and Federal Reserve Bank of Philadelphia Research Department Visiting Scholar; Nicholas Zarra, New York University Stern School of Business.

Q&A...

with Chris Severen, an economist here at the Philadelphia Fed.

Chris Severen

Chris grew up in rural Texas and Tennessee, and, after graduating from the University of Texas at Austin with a degree in Latin American studies and economics, he worked at an energy efficiency consultancy. In 2017 he completed his PhD at the University of California, Santa Barbara, where he was advised by faculty in both the Department of Economics and the Bren School. His research interests span urban, environmental, and development economics. You can learn more about Chris at https://cseveren.github.io/.

How did you become interested in urban transportation?
I've always been interested in transportation systems. I mostly lived in small towns until I went to college, and throughout high school I'd drive 40 or more miles in a day. That was just normal. Living in Austin [for college] showed me the other side of that. Austin is where I began to use bikes and busses. It was easier when I was a student, because the busses that served central student corridors ran frequently. Once I moved away from campus, I did that less. In most cities, busses designed to serve workers don't function as well as busses designed to serve students.

You're currently working on a paper about transportation in Mexico City. What are you learning about Mexico City's transit system?
The private automobile is becoming an increasingly common mode of transportation in middle-income cities like Mexico City. When that happens, there's lots of problems associated with congestion, air pollution, automobile safety. Mexico City has tried to respond to these problems. It's invested massively in infrastructure, building rail and bus rapid transit lines. When you provide good transit, people like it, and that's true even if it's a bus rather than a train.

What makes transit "good"?
The most important things are headways [waiting time between vehicle arrivals], safety, and whether it goes where you want it to go.

Why are you building a dataset of historical county-level vehicle registration data in the U.S.?
Before World War II there was a lot of regional variation in how and whether cars were adopted. Los Angeles in the 1920s had something like 2 to 3 times as many cars per capita as Chicago. And this is in an era where both cities had extensive transit networks. It seems that this early adoption [of automobiles in Los Angeles] paved the way for what happened later. In the absence of a public transit system or a walkable city, cars represent access to opportunity and mobility. So it's interesting to understand how that early access played out before we fully shifted to being an automobile nation [after World War II].

Another paper you're currently working on is "Driving, Dropouts, and Drive-throughs: Mobility Restrictions and Teen Outcomes." What have you learned so far in this research?
We're looking at how the adoption of graduated driver's license laws may limit mobility for some teenagers. There might be these substitute activities where, if I now have to be in school [because I'm no longer old enough to get a license], maybe I won't work, but maybe it was the work that was really valuable to me. Preliminarily, we find that things go in the direction that you would expect. People are more likely to complete high school and work less. But we're trying to nail down the exact degree of substitution.

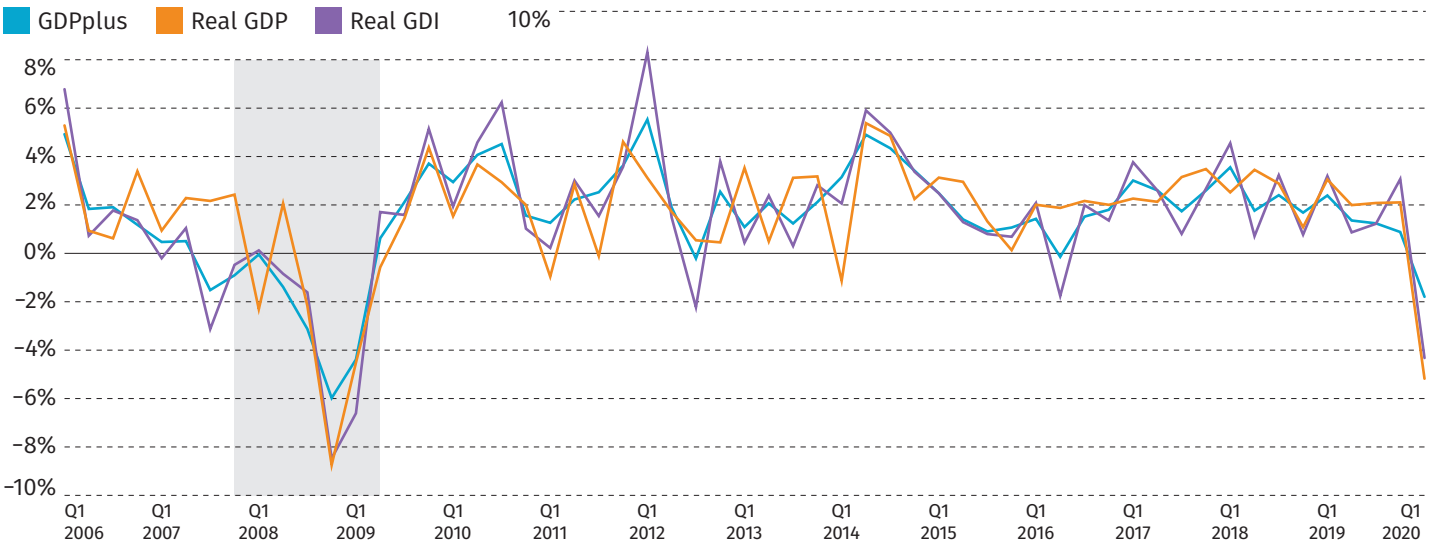
What did you learn from your study of the effect of climate change predictions on current land markets?
There is evidence that people are beginning to associate specific shocks they are experiencing in their life with climate change. Asset prices should reflect people's expectations about the future, not just the past, so we wanted to test whether land, an important asset, reflects forward-looking beliefs and expectations regarding climate. We found evidence that there is actually a fair amount of weight put on future climate forecasts, and that weight had been increasing over time, and it was stronger where people believed in climate change.

If you were teaching urban economics to college students, what would you make the course's key takeaway?
Cities are incredible engines of productivity because people come together and have new ideas and create things, but there are costs to being so close together. Forward progress comes from developing the technologies and institutions that allow people to benefit from exchanging ideas and being in proximity without facing, you know, the Bubonic Plague—or sitting in traffic for two hours.

Data in Focus

GDPplus

The Philadelphia Fed collects, analyzes, and shares useful data about the Third District and beyond. Here's one example.



Note: Average of 1990 = 100. Shaded areas indicate NBER recessions. **Source:** Federal Reserve Bank of Philadelphia

Economists often talk about total expenditures on goods and services produced in the U.S. economy, also known as real gross domestic product (GDP). But there's another way to measure the economy. Real gross domestic income (GDI)—which, like GDP, is calculated by the Bureau of Economic Analysis (BEA)—measures payments such as salaries to the workers who produce the goods and services. From an accounting perspective, GDP should always equal GDI, but the BEA computes each measure using different survey information. That means GDP almost never equals GDI. Both measures are useful (even though they often disagree), but sometimes we want one estimate of the underlying and unobserved U.S. economic activity driving the BEA's official measures. In 2013, the Philadelphia Fed's Real-Time Data Research Center launched just such a measure. GDPplus combines GDP with GDI to produce one, easy-to-read measure of aggregate economic activity. GDPplus is designed to complement but not replace the BEA's measures. As Assistant Director and Assistant Vice President Tom Stark explains, "We think analysts and policymakers will use GDPplus as well as the BEA's estimates of GDP and GDI to improve their understanding of the dynamics of the U.S. economy."

Learn More

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