

urbanism

NEXT

AUGUST 2017

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance

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SCI's Urbanism Next initiative focuses on how advances in technology such as the advent of autonomous vehicles (AV's), the rise of E-commerce, and the proliferation of the sharing economy are having profound effects not only on how we live, move, and spend our time in cities, but also increasingly on urban form and development itself.

Through a multidisciplinary approach, this research initiative gathers the latest thinking on the state and trajectories of these technologies, analyzes the potential implications for urban form and development, and projects how these changes should affect current design, planning, and development decisions.

While substantial research on the technological aspects of autonomous vehicles and systems themselves exists, the Urbanism Next Research Initiative is focused on addressing the shortage of systematic exploration on their secondary effects on city development, form, and design, with implications for sustainability, resiliency, equity, cost, and general livability.

SCI is building a national network of thought leaders from the private sector, public sector, and academia to address these topics.

Additional research and information on our blog: urbanismnext.uoregon.edu

INTRODUCTION

Autonomous vehicles (AVs) are already being used and their proliferation is inevitable. AVs have the potential to fundamentally alter transportation systems by averting deadly crashes, providing critical mobility to the elderly and disabled, increasing road capacity, saving fuel, and lowering emissions (Fagnant and Kockelman 2015). Eighteen states and the District of Columbia have enacted legislation regarding AVs¹, and the governors of four other states have signed executive orders about AVs² (National Conference of State Legislatures 2017). In 2017 there were 33 states that had introduced AV legislation, up from 20 in 2016 (National Conference of State Legislatures 2017). As of June 2, 2017, there were 31 companies that had received permits from the California DMV to test autonomous vehicles, and the list is getting longer each month (California Department of Motor Vehicles 2017). In Berlin, Deutsche Bahn, Germany's largest train and bus operator, is testing a driverless twelve-passenger shuttle bus (Scott 2017). Over 20 pilot or existing AV public transport programs have taken place in Europe. And the most recent AV testing permit recipient in California is a private shuttle bus operator—Bauer's Intelligent Transportation (California Department of Motor Vehicles 2017).

Much has been written about the technical challenges of integrating autonomous vehicles into traffic patterns, but to date, there has been little consideration of the significant secondary impacts that AVs present. This project aims to fill that gap. AVs have the potential to transform cities – but whether the impact is positive or not depends on how the AVs are used. If AVs use clean fuels, are used for shared rides, and become an on-demand service rather than an owned product, cities and society may benefit. Consumer-owned cars are inefficient and underused assets – most are used for less than one hour per day (OECD 2015), sitting idle for about 95 of their life, and about 10 percent of the average American's budget goes to the cost of purchasing and fueling private vehicles (Bureau of Labor Statistics 2016). AVs will impact land use planning, transit use, government revenues, and may exacerbate societal inequality by reducing the viability of existing public transportation services.

The goal of this white paper is to consider the impact of AVs on municipal budgets. AVs create a “potential rat's nest of a budgeting challenge” (Fung 2016). This paper seeks to begin the process of untangling that rat's nest, and provide the foundation for future phases of the project that will consider potential additional revenue sources to fund the infrastructure changes that may come from the integration of AVs as well as land use planning implications.

¹ Alabama, Arkansas, California, Colorado, Florida, Georgia, Louisiana, Michigan, Nevada, New York, North Dakota, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Vermont, and the District of Columbia.

² Arizona, Massachusetts, Washington and Wisconsin.

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance

BUDGETARY AND FINANCIAL IMPACTS OF THE SHIFT TO AVS

With nearly 90,000 local governments in the United States, there is undoubtedly substantial variations what local governments do, how they do it, what they spend money on, whom they serve, and the kinds of revenues they utilize. The goal of this white paper is to provide a starting point for what many local governments might need to think about in their budgeting process to deal with the coming shift in how transport happens in cities.

We use San Francisco as a base example in this document because they offer a wider range of services than a typical city—as they are a consolidated city and county. They are also in a state that has a sales tax, unlike cities in Oregon where we are based. We are also primarily focusing on the General Fund rather than all types of funds within a city budget (with a few exceptions including: Airport and Solid Waste Collection). This is just to keep focused as we start this process, rather than thinking that Enterprise Fund activities would not be affected, as we know they will be.

The goal of this white paper is not necessarily a line item by line item examination of the budget but rather to talk in more general terms. A city like San Francisco has a diverse revenue base. They rely less on property tax revenues than an average city government nationwide but do not look too different than a typical Californian city. The mix of taxes varies substantially state to state. We will take a look a few of the largest revenue sources followed by a detailed look at effects on expenditures.

REVENUES

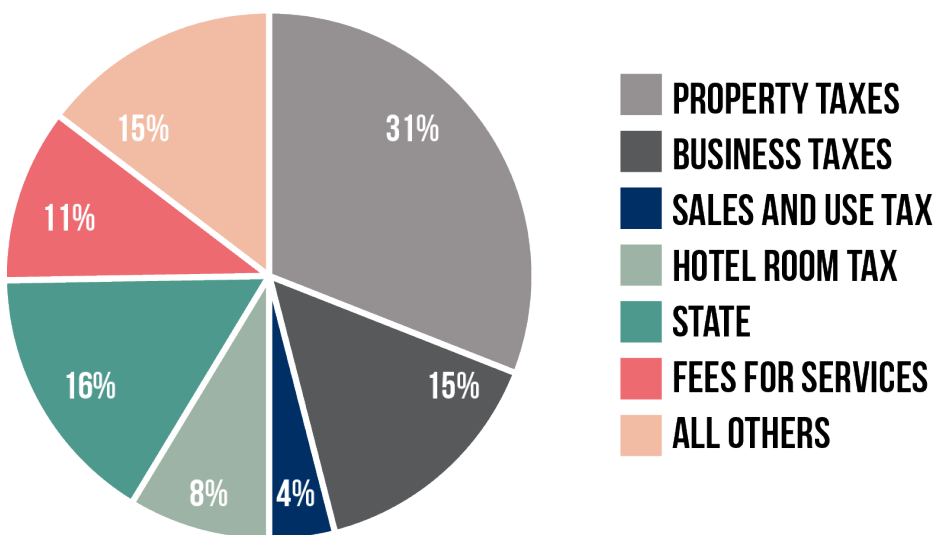


Figure 1: Adapted from General Fund Revenue by Source (San Francisco, CA 2014)

Property Taxes: Property taxes are going to be the most obvious place where we would expect to see changes in revenue potential. Parking is the single largest land use in central cities (Shoup 2005) with between 14% to more than 25% of land being used for this purpose (Gardner 2011, Chester, Fraser et al. 2015). It is suspected that with AVs that we will need up to 90% less parking spaces (International Transport Forum 2015, Zhang 2015). With this, we may see an increase in project density as the need to accommodate parking no longer limits the number of units that may fit on a site. This would increase potential property values - and hence tax revenue - of a given site or development.

Over time we would expect that new residential buildings in a city like San Francisco would be required to have fewer and fewer parking spaces. As parking is no longer a competing land use, this frees up land to be used for other, more productive and valuable purposes increasing property tax revenues. On the one hand, this may increase property values as higher and better uses expand. On the other, this would greatly increase the overall land supply available for these uses, potentially temporarily depressing land values throughout urban areas.

Further study is needed about the interaction between property tax limitations and the changes that might be wrought by AVs. For example, in California, the enactment of Proposition 13, which limited increases in property taxation based on 1975 assessed property values, property tax revenues declined sharply. Under Prop 13, assessed values may not increase by more than 2 percent per year, but a change of ownership will reset the assessed value to the purchase price. The maximum rate of property taxation is limited to 1 percent, excluding payments for preexisting indebtedness. Localities in California have turned to other sources of revenue, such as local sales taxes, utility taxes, hotel taxes, and development impact fees. Per capita local tax revenues in California have grown more slowly than in states without such limitations. (Taylor 2015) Nineteen states and the District of Columbia have property tax limitations, although California's is the lowest (Haveman and Sexton 2008). Proposition 13 has discouraged property turnover in California, and commercial property tends to be leased rather than purchased. Therefore, increases in property value may not necessarily lead to significant increases in property tax revenues—even if the underlying land does increase in market value.

Parking related revenues do not represent a large share of most cities' revenue streams. On average, nationwide parking revenue constitutes less than 2 percent of local revenue sources (United States Census Bureau 2016; Lincoln Institute of Land Policy 2017). However, we would expect to see lower revenues from parking meters, parking garages, and tickets issued for illegal parking or expired meter fees

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance

as the need for parking could diminish dramatically. The decline in revenue would be expected not only from the diminished need for parking spaces near the activities we are going to (retail, work, entertainment, home) but also from a projected decline in personally owned vehicles—with some reports of 90% fewer vehicles on the road. The risk of declining parking revenues actually has the potential to rock the financial sustainability of municipal finance harder than just those fees/fines. It is important to recognize that a good number of parking structures are backed by revenue bonds, which are dependent on those revenues to pay back bondholders. Without parking revenue, a local government could be in danger of going into default if parking garages are no longer necessary. This has implications for access to credit and borrowing costs that go beyond a parking meter or parking garage. That is not to say a government could not repurpose a parking garage into retail, commercial, or residential spaces (because they will have to do this) it is just that this process may take years to complete and put substantial financial pressures on the issuer of those bonds in the meantime.

AVs also have the potential to allow for commutes that are further from the place of work. Individuals may be more likely to commute further if they were able to actively use their time during their 'drive' to work. In addition, AVs will have the potential to travel faster than human-driven cars as vehicles are able to talk to each other, can drive closer to one another more safely, and thus move passengers more quickly—though some speculate they could also lead to more congestion and slower commutes. These factors have the potential to increase urban sprawl and metropolitan footprints. This could add to land values in cities further from the city center but also reduce the value of existing close-in suburbs. Cities with Urban Growth Boundaries, like many in Oregon, may have different experiences that would limit this spread, but Atlanta or Charlotte would not have these limits on their already diffuse population.

Cities with struggling, high-poverty inner-ring suburbs may feel a pinch from AVs as wealth could have the potential to flee further into the suburbs as commutes become easier. Some examples of these cities could include the likes of Hamtramck outside of Detroit, or East Cleveland outside of Cleveland, or Camden, NJ near Philadelphia, to name a few. These areas might see a further decline in property values beyond what they have seen in recent decades (Hexter et al. 2011).

Similarly, there are questions of how the demise of big box retail, strip malls, and malls would fit into this picture. With the rise of e-commerce, traditional brick and mortar retailers have felt a dramatic pinch on their profits, and consequently, many cities have already begun to adapt, or struggle to adapt, to what to do with retail areas that were once thriving and now struggle. We expect this trend to continue with the rise of e-commerce. Thus, there could be some additional downward pressures on these

types of retailers, diminishing commercial property tax revenue. Of course, the decline in commercial property value could have spillover effects into nearby residential neighborhoods, depressing property values (and taxes raised) in those areas as well. To combat already declining shopping areas, some commercial property owners are pushing towards creating a shopping experience by mixing amusement, dining, and shopping. This model of retail could fare even better as parking becomes less of an issue in these entertainment/shopping districts.

Business Taxes: San Francisco reports that their “Revenues from business taxes and registration fees follow economic conditions” (City & County of San Francisco 2016, 46). These taxes “are sensitive to changes in the economic condition of the City” and are primarily affected by local-level “employment and wages” (City & County of San Francisco 2016, 46). These types of taxes generate more revenue as more people are employed and working in a city. If the density of the city were able to grow by replacing parking lots and spaces with more retail, commercial, industrial, or residential properties, then we would expect a city like San Francisco to generate more revenues from this tax as land use changes because of AVs.

Sales and Use Taxes: In April 2017, Amazon announced that they were going to start collecting sales tax on all items sold by Amazon nationwide. Amazon accounts for half of all online sales—and half of Amazon’s sales are from Amazon directly, the other half are by independent retailers selling through Amazon. Thus, this decision effectively taxes ¼ of all online sales immediately. Traditional brick and mortar retailers have complained for years about online sales being tax-free, but that luxury may soon be over as states take a harder and harder look to find new revenue sources. Oklahoma, for example, lost out on “\$45M in Sales Tax Due to Amazon Sales” in one year alone (Trotter 2016). This is not a trivial loss of revenue, so state tax auditors are going to take a harder and harder stance as more and more retail goes online, up to and including simply estimating “the amount of sales [a business] had done,” and then just send a bill to collect these funds (Taxify.co 2016).

The impact of sales tax revenues is likely also to be felt differently across the urban-suburban landscape as more retail transactions take place online. There are many bedroom communities that could stand to benefit from increased online sales tax collections more so than some urban areas—as some of these bedroom communities currently have few retail establishments, but many residents shopping online. Presumably, the place where goods are sent to would receive the newly collected sales tax revenues, rather than the places where the big box retail, strip mall, or shopping malls are or were located. This means that there is a potential for sales tax revenues to flow to local governments that never collected much in sales tax, while the cities that previously benefited from sales tax revenues by being host to large malls, big box stores, and strip malls could see sales tax drop more dramatically.

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance

Sales taxes on automobile purchases would also likely see dramatic declines as more people shift toward a shared AVs rather than personal ownership. If only 10 percent of vehicles currently on the road are needed, then lower sales tax revenues would be collected from these sales as well. Though some have postulated that the AVs on the road may not last as long as our current vehicles because they will be in use far more of the time than the current fleet of vehicles on the road—so the decline in revenue is not likely to be a full 90 percent. An additional complication on the fleet vehicle model is that this would give lobbying power to the fleet owners to push for lower sales tax rates on their purchases. They could also use incorporation rules to purchase vehicles in states or jurisdictions with lower sales tax rates (or no sales tax at all) and then later transport those vehicles to locations where they would be used. If the fleet owners are replacing their fleets regularly, they may also be able to take advantage of “Like-Kind Exchanges” replacement of vehicles to avoid paying federal taxes (Internal Revenue Service 2016). For example, a fleet owner might pay taxes on the purchase of the AV fleet, we will say it has a fleet of 50,000 AVs. As they replace each vehicle, federal tax laws allow the firm to not pay additional taxes on the replacement vehicle for the fleet, since this capital good is simply maintaining the production capacity of the fleet owner. They would pay taxes on vehicles that add to the overall size of the fleet (in our case above the stated fleet size of 50,000 vehicles). States and localities would want to address these potential loopholes early on to hedge against a potentially large hit to sales tax revenues.

The industries and retail associated with the auto industry could also get hit hard with the shift from individual ownership to fleet models. Would we still need auto detailing and repair shops if a fleet owner had their own facilities to clean and repair the vehicles? While not all of this decline in retail would hit sales tax revenues directly—as many services are not part of sales taxes, it could impact other revenues sources for cities like income taxes or property taxes.

So, what is the take home in the era of AVs? We would expect that the gap in collected versus uncollected general sales tax revenue will continue to decline because cities and states simply can no longer sit by and allow for untaxed sales to go on. This change will not affect Oregon, as it like a few other states, do not have sales taxes, but California and others will certainly step up tax enforcement. The cost to governments to monitor tax compliance will almost certainly increase as more and more retail occurs online.

Motor fuel excise taxes are at times applied at the local level—together with Federal and State excise taxes. Fuel tax revenues are declining throughout the United States. Whether we shift to an AV model or not, more and more vehicles are shifting to an

electric power source. The decades-long lack of political will at the federal level (and many states) to increase the per gallon motor fuel tax rate has decimated size of these excise taxes as a reliable source for building infrastructure for transportation. While rates/gallon could be adjusted, the decreasing reliance on gas or diesel for transportation will require a different approach in the very near future. The replacement revenue could come from a variety of sources, including per mile charges, toll roads, additional excise taxes for electricity generation, geometry taxes, and others. The bottom line is that this is one of the important taxing issues that will have to be addressed in the very near future. Our future white papers will seek to further flush out the feasibility of these fuel excise tax alternatives.

Fees for Services: Fees and user charges are highly specific to the types of goods or services that a government provides. One area of revenue that has the potential to change in the era of AVs is vehicle-charging stations. While these could be provided by the private sector—as motor fuel has for years—many cities have public utilities that provide power already, thus electric vehicle charging may become a bigger source of revenue over time.

There has been some speculation that cities themselves will get into the AV fleet business. They would provide fleets of AVs that you could call up, just like people do with Lyft and Uber today. This could provide a substantial revenue source—though it could also be a substantial cost as well. Similarly, public transportation may be substantially affected by AVs. Some speculate that public transit ridership could plummet with AVs wider adoption. This could make providing equitable public transit more difficult over time—though typically fare box revenues only account for a small share of total support needed for each ride. In a sample of 28 large US cities, Transit farebox revenues accounted for about 21 percent of total revenues in 2012 (Pierson, Hand, and Thompson 2015). However, transit farebox revenues accounted for less than 1 percent of total ownsource revenues for those same 28 governments (Pierson, Hand, and Thompson 2015). This means that on whole a potential dip in farebox revenue would not likely damage overall financial condition of cities, but there is a potential for severe impacts on public transit systems. It may be that public transportation will simply look a whole lot different in the future. It could be smaller vehicles, carrying fewer passengers, in a more direct route to and from the desired destinations. Uber's (Uber Pool) or Lyft's (Lyft Line) shared ride vehicles could be an example of what this might look like in the future—without the driver of course. And as previously mentioned, a number of European states and cities are looking at the integration of AVs as public transit already (Scott 2017). Nonetheless, the revenue impacts are not yet clear. See Appendix.

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance


IMPACTS ON EXPENDITURES BROADLY

San Francisco spends about 53 percent (almost \$3.9 billion) of its non-capital General Fund budget on personnel and the remainder on non-personnel items (this includes: supplies, equipment, contractual services, debt service, maintenance, grants, and transfers to other funds). This ratio of personnel to other spending is not anything particularly unusual—except that San Francisco may be spending less on personnel and more on non-personnel as a share than many other cities. It would not be uncommon for a city to spend a much larger percentage of their budget on personnel—with typical ranges often between 60-80% of a local government's operating budget. San Francisco spends an additional \$1.4 billion on contractual/professional services—which could mean as much as 73% of their non-capital General Fund spending was on personnel, just through contracted mechanisms rather than all through the hiring of governmental employees.

One of the shifts we expect to happen as a result of AVs and automation more generally is a shift away from personnel expenditures toward automated service delivery. We will detail where within the government we are projecting that this happening in our service-by-service breakdown in Appendix 1. Generally, we would imagine a world in which many of the drivers of vehicles would be replaced by AVs, but not necessarily all of them. This could potentially have equity implications—we will specifically address some of the equity concerns that AVs raise in the 'Equity' section below.

The cost of capital and the types of capital expenditures may shift as well. Some project that economic instability will result from the economic transition toward a more and more automated world, thereby creating higher levels of economic uncertainty, higher rates of unemployment, and greater fluctuation in government revenues. This uncertainty may have the result of lowering bond ratings, which will increase the cost of borrowing for cities.

As automation and artificial intelligence (AI) are further developed, there are many potential areas where people are likely to be replaced by automated vehicles or processes. So, for example, instead of buying a traditional trash truck (which have already becoming extremely automated, often requiring only a single driver controlling a robot arm to pick up trash cans), a city could buy an AV trash truck that could collect waste without an employee in the vehicle. One could imagine that this would have a higher upfront capital cost to the city, but have lower operating costs. The decisions to shift to an AV would have to balance out the expected savings of having a truck with no employees over debt service paid on that truck over its life (say 10-15 years). It would seem likely that the excess of capital cost would be substantial as this technology was first introduced, but decrease over time as the cost of AVs came down (in-line with



traditional vehicles). Additionally, truck and vehicle operators are a significant source of employment for lower skilled laborers. Therefore, governments shifting toward automated vehicle operations for service provision could have a potentially significant impact on individuals with lower levels of education and income, and consequently implications for equity (discussed more below in the 'equity' section). Naturally, the effects of the shift to AV trucks goes beyond those vehicles in government service to the long-haul trucking industry is particularly interested in AV technology. This sort of workforce shift analysis is outside of the scope of the white paper, but may be examined in our future white papers.

It is not expected that the shift to AVs will happen overnight, so the shift from personnel expenses to capital ones would be gradual. A subtext of this shift to AVs away from human operators is the question of how unions will react to all of this. If unions are resistant to this shift (quite likely) the transition could actually be costlier as cities make changes but need to maintain or carry larger personnel costs. Jeff Tumlin (2017) has noted that the natural rates of attrition within organizations would likely coincide quite well with the transition to AVs—thus lessening the blow to individual workers, but hitting the overall workforce quite hard in the long run. In this transition, local governments will see drops not only in their active payrolls but also in their long-term costs like pensions and retiree healthcare (OPEB). The shift obviously would not lessen the burden of people who are already guaranteed a pension or healthcare benefits but looking out several decades the savings could be seen. Again, the labor and workforce economics of AVs is outside of the scope of this white paper, even though it does have the potential to be a huge hit to the bottom line of cities.

POTENTIAL EQUITY ISSUES



Labor: Lower skill level jobs, which have been hit hard by automation in recent years, will continue to get hit hard by AV-related automation of tasks. From a public-sector employment perspective, we could see a lot of drivers being replaced by AVs. Many of these jobs require a lower level of education; yet provide living wages for those individuals. However, many jobs that require higher levels of education might be harder to replace. Meanwhile, growth area for employment within government is likely to be seen in the IT sector, data analysts, and other highly-skilled jobs (Marshall 2017). This disparity by education attainment has real concerns for equity—and not just in the public sector but in the economy more broadly as truck drivers, for example, are likely to be largely replaced by AVs.

We see public transportation as one of the biggest potential areas for increasing inequality in transportation as a result of AVs. There is a wide-ranging speculation of the possibilities of the effect that AVs will have on the make up our transportation

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance

system. If the current public transit systems remain largely intact, AVs could potentially provide the expanded coverage and access for aged and disabled individuals that have trouble getting the first and last mile of their trips accomplished via public transit—thus AVs have the potential to expand equity. However, if AVs have the potential to decimate support and funding for public transit, as those with means simply transition to utilizing fleet AVs for transportation (much in the same way many now rely upon Lyft and Uber). With ridership and ultimately revenue declining, public transportation could be left to only those without means to pay for AVs. This could further lead to budget destabilization of public transportation agencies and cuts to services which could have a disproportionate effect on the poor. Governments would likely to have to find ways to subsidize either access to AVs or run their own fleets to provide adequate transportation coverage.

Concerns have been raised about how AVs may enable a further suburbanization of cities by making transportation to further reaches easier—one could work and commute simultaneously. This would further exacerbate the flight of capital to the exurbs, which would perpetuate the struggle of central cities and inner-ring suburbs that have been ongoing since 1960.

CONCLUSION

Autonomous vehicles, E-commerce and the sharing economy will have profound effects on municipal budgets. While only a preliminary analysis, this report points to a large degree of disruption brought about by these technologies. The changes in the departmental distribution of revenue and expenditures, not to mention changes in overall budget numbers, will affect the ease of service provision and will require a re-balancing of budgets and priorities.

Cities must begin to incorporate these changes in their budgeting, capital improvement plans, and organizational structure to both protect themselves against detrimental effects and to be able to effectively leverage these emerging technologies to further community goals.

APPENDIX 1

Impacts Department-By-Department of City's Budget

In the following section, we have taken a department-level focus to think about what might be changing for city budget at a finer grain level of thinking. While this list was based on San Francisco, we added and subtracted a few departments for brevity and inferences beyond the case city.

The departments shown in this table do not represent all departments in the government. Nor do they represent all spending—you will note they only comprise slightly more than half of all spending. We have focused in this table showing only the departments we thought might be most impacted by AVs. We also left out a number of non-departmental or internal service spending functions.

DEPT.	BUDGET IMPACT	WAYS TO ADAPT	% OF EXPENDITURES
Airport	<p>Expenditure: Upkeep of large parking structures and parking with lower parking demands.</p> <p>Lower personnel costs as some drivers of airport vehicles are replaced AVs.</p> <p>Revenue: Reduction in parking revenues, rental car tax revenues, and taxi/car share related fees or taxes. Parking currently accounts for 13 percent of SFO's total budget—and this has been growing in recent years. Car rental companies contribute about 6 percent of SFO's direct revenues.</p>	<p>Repurpose parking garages for AV storage when few rides are being demanded.</p> <p>Assess fee on AV rideshares to/from at the airport (similar to taxis or rideshare currently utilized). Ground transportation fees (from Lyft, Uber, Taxis, and public transit agencies) currently account for about 4 percent of SFO's revenue—these fees would have to be directly addressed.</p>	11%

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance

DEPT.	BUDGET IMPACT	WAYS TO ADAPT	% OF EXPENDITURES
Assessor/Recorder	<p>Expenditure: Substantial increase in assessments will be needed as the uses of property changes. This will increase budgetary demands over time, not necessarily in one year.</p> <p>Revenues: Potential for large increase in property values as parking is no longer needed. This allows for both higher density buildings (can go taller b/c parking is not a limitation) and more of a building project being used for income generation (i.e. the parking for a building is typically a loss for builders).</p> <p>E-commerce could push value of big box retail land areas downward—but this could also free up more land for (re) development and put it into a higher value use in the long-run.</p> <p>Other: With potential shifts in location preferences for residential areas – and potential shift away from the desire to be proximate to other areas (i.e. the diminishing of transit and TODs), property values will shift. A challenge already exists to the redevelopment of brick & mortar retail that has been on decline with e-commerce—this issue will get worse. Auto-oriented uses (dealerships, repair shops, parts stores, gas stations, car washes) may all go away or be a very small niche market (think typewriter repair shops).</p>		0.25%

DEPT.	BUDGET IMPACT	WAYS TO ADAPT	% OF EXPENDITURES
City Planning	<p>Expenditure: Potential for a short-term rise in personnel costs associated with the adaptation of cities for AVs (plans reviews up and the redevelopment of brick & mortar retail). Many existing plans will need to be revisited if they have not accounted for shifts we are talking about (thinking of RTP, comprehensive plans, specific plans, etc). These plans could become obsolete fairly quickly. Transportation planning, in general, will need to be rethought – and projections and expected trends will potentially be far off of what was considered – creating its own havoc.</p> <p>Revenue: Not a significant issue.</p> <p>Other: Potential large negative externalities for certain areas (much more traffic, loss of transit service, loss of property values (for some)) will potentially lead to upset and energized residents that will want to see change and ask how city is helping deal with these things.</p> <p>Redesign of streets could also be a big demand – less lane width and number of lanes may be needed – space up for grabs. Question of how to enhance other modes (or, in a nightmare scenario, how to separate modes completely so that fast moving AVs do not run people over or so people do not step onto the street and create gridlock as all AVs stop to not harm pedestrians).</p>	<p>Zoning overlay could allow for easier wholesale changes to zoning and uses of properties across cities.</p> <p>New comprehensive planning process needs to accommodate changes to parking minimums, roadway widths, pick/up drop off cut outs, non-motorized transportation (walking, biking), roadway sensors for AVs.</p> <p>New regulatory structures may need to be more flexible as we lead into an era of quick transitions in the built environment. Land use regulations might set out particular needs depending on what development conditions exist. For instance, if shared AV use is at X%, then parking ratios will be at Y.</p>	0.4%

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance

DEPT.	BUDGET IMPACT	WAYS TO ADAPT	% OF EXPENDITURES
District Attorney & Courts	<p>Expenditure: Fewer traffic related cases being prosecuted by city could lower legal costs. There could be lower demand for court spaces as fewer people are in courts for traffic related cases. Higher costs for data analysts and IT specialists related to the availability of more data from AV-mounted cameras.</p> <p>Revenue: lower citation revenues and court revenues.</p> <p>Other: AVs will have cameras mounted on them. This provides an opportunity for the DA or public defenders to access to cameras all over the city at any time of the day. The Constitutionality of accessing these data would have to be established but could potentially decrease the cost of prosecuting crimes.</p>	<p>Develop model legislation to deal with the constitutionality of accessing new troves of data ahead of time rather than being reactive.</p> <p>If justice system is dependent on court revenues for budgetary purposes (moving violations, for example), they need to start mapping alternative revenue sources or cutting staff.</p> <p>San Francisco has a security camera registration program in place to let the DA know about camera footage that could aid in prosecution. This could provide a model for AV owners to voluntarily provide video footage, should wide-scale video access become a substantial constitutional issue.</p>	3% (Including: District Attorney, Courts, Administration and Public Defender)
Economic & Workforce Development	<p>Expenditure: Job retraining for workers that have been automated out of jobs (truck drivers; taxi drivers; delivery drivers; traffic cops; street sweepers; bus drivers; public works road crews; distribution center and delivery workers).</p> <p>Revenue: If e-commerce's reach expands further, some cities that are highly dependent on commercial real estate for property tax revenues and/or sales tax will be hit particularly hard.</p> <p>Other: Redevelopment activities associated with old malls and retail spaces. In terms of economic development, cities are going to be seeing a large shift in the ED playing field, so there will need to be a concerted effort at re-thinking opportunities and aggressively trying to carve out market niches for communities.</p>	<p>Work with high schools, community colleges, and universities to develop job retraining programs.</p> <p>Continue push for full collection of sales tax for e-commerce.</p> <p>Coordinate efforts with planning department with economic redevelopment of brick & mortar retail.</p>	0.3%

DEPT.	BUDGET IMPACT	WAYS TO ADAPT	% OF EXPENDITURES
Emergency Management	<p>Expenditure: AV emergency response during major events could improve service levels, but might be costly.</p> <p>Revenue: Limited revenue generated currently.</p> <p>Other: Utilize AVs to produce a synchronized emergency warning system (all horns on the street honk at once) could improve outcomes for things like tsunami and tornado. And there will be a strong need to figure out backup plans if AVs all start to fail at some point. What happens if there is a sudden bug or a cyber-attack and nobody can move in the city? What happens when the earthquake hits and centralized control of cars goes down and nobody can use the vehicle that is parked in their driveway.</p>	<p>Contingency planning will be essential for emergency management that relies too much on technology to deliver core services during an emergency. Identifying alternative service delivery will be vital after an earthquake or hurricane when power and computer systems may be down.</p> <p>Push AV manufacturers to make AVs solar powered and capable of producing electricity for the grid or localized use. This could solve electricity generation issues during times where the grid is down. This will also require retrofitting electrical grid to handle this electrical generation.</p>	0.07%
Fire Department	<p>Expenditure: May be higher capital expenditures with some AV-based fire response or emergency dispatch to roadway incidents. However, fewer roadway incidents (fewer accidents because AVs are better drivers) would be expected, resulting in lower demand for EMTs. Might not need ambulance drivers (ore fewer of them), but still might need same level of personnel to provide care on site of incidents.</p> <p>Revenue: Lower revenues from transport to hospitals (also fewer trips, so lower costs), but otherwise limited revenue generated currently.</p>	Same situation as Emergency Management.	4.3%

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance

DEPT.	BUDGET IMPACT	WAYS TO ADAPT	% OF EXPENDITURES
Public Works (includes Streets; Sidewalks; Bike Paths)	<p>Expenditure: Street redesign; expense of roadway sensors (if needed) to communicate roadway info to cars or to network; increases expenses of better roadway markings (painted stripes on roadways), more computing needs to feed traffic or roadway info to AVs; fewer street sweeper employees needed--AVs could sweep roads automatically; potholes identified and filled automatically with an AV; multi-modal infrastructure demands are unclear--would depend on how much people would demand public transit with personal/fleet AVs. Also, cost of all new vehicle fleet.</p> <p>Revenue: In some cities a public works or transportation department might be the central operator of parking lots or on-street parking. In San Francisco this function is spread over 10 departments, depending on where those lots are located (park, airport, transit station, etc). We will put all of the discussion of parking here for simplicity sake. Overall parking accounts for about 2 percent of the cities total revenues (all fund types), but plays a larger part of some individual fund's revenue sources (see Airport above for one such example).</p>	<p>As trips increase in number and length, congestion will become a key problem. Cities must shift the way they manage the use of public right of ways and have it act as less of a public good and more like a utility with a limited resource. Capacity will become highly valued and things like dedicated right of way will have tangible economic value.</p> <p>Cities should consider a shift to a tax on the amount of space being used by person on streets – a geometry tax. This will discourage empty AVs from circulating and will encourage smaller vehicles that are filled to capacity with more individuals. Cities should consider monetize pick-up and drop-off sites instead of parking spots. These areas will be in high demand on the street and directly in front of destinations. Maybe you pay a fee to pick-up/drop-off in front of the office building and a lower fee for doing it at some pod/center a few blocks away.</p>	2.5%

DEPT.	BUDGET IMPACT	WAYS TO ADAPT	% OF EXPENDITURES
Technology	<p>Expenditure: Greater technology needs for a city; sensors in roadways; computers to transmit info to cars; info on the number of parking lot spaces to AVs (so they do not drive aimlessly while owner is at the bar). If cities manage their own fleets (as opposed to just contract with Lyft), big tech needs.</p> <p>Lots of data coming in overall (big data) – especially around transportation – and a strong need for analysis for this.</p> <p>Revenue: Nearly all revenues are from entities within the government (Internal Service Fund). Revenues would likely increase for this department as the demands for more technology and support would increase with the increased flow of data from/to AVs. The source of revenues would likely be other governmental entities, thus increases expenditures in other departments.</p>	<p>Assessing annual or one-time registration fees to pay for sensors that allow for capital, operating and maintenance costs. These fees could be captured in the vehicle registration process.</p>	1.3%

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance

DEPT.	BUDGET IMPACT	WAYS TO ADAPT	% OF EXPENDITURES
Public Transit (buses, trains, etc.)	<p>Expenditure: Depends on economics of AVs; if mass adoption of fleet vehicles there might be less of demand for buses/trains/ etc. (Fehr and Peers study predicts up to 46% drop in transit use); could have lower operating expenses of buses/trains if they are drive by computers; higher tech costs; if buses are on demand and point-to-point (fleet AVs for public transit purposes) then there might be higher capital expenses with a larger fleet of smaller sized vehicles spread across the city. The potential shift in park and ride (if many people just decide to ride all the way). Overall, there will be a huge shift in the way transit is used – this will require planning and investment.</p> <p>Public transit services could become a fleet operator of AVs and compete with the private providers.</p> <p>Revenue: If fewer riders are using public transit, and more using private AV Rideshare for the same purpose, then there will be clear hits to the revenues of the agency. If the public transit agency becomes a fleet operator then revenues would increase to accommodate more riders.</p> <p>Other: Pick-up/drop-off will become an issue if no one is parking—may have to completely redesign stations to accommodate this. Could be a boost for first/last mile—thus permitting/encouraging more people to use transit. Some existing/recent investments may not pay off if they are out of sync with changes that are coming. Will be a burden on agencies (imagine an agency that just built a huge park and ride structure, and in 10 years nobody is using it... how do you pay for that). Parking revenues at park and ride facilities could be hit as people utilize AVs to get to/from home or work from a transit station or use only AVs (and not public transit) for their ride to/from work.</p>	<p>Public transit should not sit back idly and allow the market to change around them. They should be active in pushing for equity of transportation options while AVs become more common. If fleet AVs become dominant, there is no reason public transit systems could not be an appropriate venue for providing, operating, and maintain a fleet within a city. Transit systems would have to work with political leaders to work out levels of subsidization to assure equity in service delivery.</p>	11.4%

DEPT.	BUDGET IMPACT	WAYS TO ADAPT	% OF EXPENDITURES
Law Enforcement	<p>Expenditure: Unmanned (or with fewer people) patrol and transport vehicles. Fewer cops needed for traffic patrols. The cost of accessing and analyzing data for law enforcement purposes could be staggering.</p> <p>Revenue: Lower ticket volume because AVs are programmed to not break traffic laws.</p> <p>Other: Lots of constitutional issues regarding data derived for AVs, since it will potentially be easier to track where people are, where they are going, and where they have been. A large number of privacy questions will need to be addressed with this.</p>	<p>Departments that depend highly on moving violation revenues for budgetary support will have to see out revenues elsewhere. Realignment of police force should be commensurate with needs in the field rather than keeping ratios the same as they are today with some portion of the force monitoring vehicle traffic rather than criminal activity.</p> <p>Law enforcement needs to work hand-in-hand proactively with courts and DA to establish constitutional uses of new sources of data.</p>	9.3% (Police and Sheriff)
Public Utilities	<p>Expenditure: Have to provide AV charging around the city with all-electric AV fleets; Uncertain the extent to which all-electric vehicle fleets would increase demands on electric grid—would we need new electric grid infrastructure?; increased smart grid tech potentially; rerouting of utilities with shifting roadway usage; Stormwater utility might be able to reduce some costs by having more green infrastructure built into road retrofits with reshaping of roadways...high initial costs, but long-term savings and improved water quality.</p> <p>Revenue: Increased electricity use is a result of AVs being electric, thus more revenues. Lower stormwater utility revenues are less impervious surfaces are found (fewer parking lots and roadways).</p>	<p>Work with AV fleet developers (public and private) to develop most efficient designs and locations for recharging stations.</p> <p>New comprehensive plans for stormwater utilities that adapt to land use changes.</p>	11%
Treasurer/Tax Collector	<p>Expenditure:</p> <p>Revenue: do we issue franchises to AV providers to operate within a city? If so you could collect franchise fees similar to cable or telephone providers. Loss of sales tax revenues to e-commerce. Loss of auto dealership and gas station tax revenues.</p> <p>Other: have to determine the public versus private delivery of AVs.</p>		0.4%

THE IMPACTS OF AUTONOMOUS VEHICLES AND E-COMMERCE

on Local Government Budgeting and Finance

DEPT.	BUDGET IMPACT	WAYS TO ADAPT	% OF EXPENDITURES
Solid Waste Collection	<p>Expenditure: Unmanned trash or recycling collection, reducing employee compensation and fringe benefit; lower workers' compensation claims with fewer (or no) workers getting hurt while collecting the refuse (could also lower liability insurance expenses and health care costs).</p> <p>Revenue: No clear changes to revenue streams.</p> <p>Other: Increase in e-commerce may result in larger quantities of packaging materials (shipping) being generated and needed to be disposed or recycled.</p>		3-7%.

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