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Pay with Promises or Pay as You Go? Lessons from the Death Spiral of Detroit*

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ABSTRACT

As part of compensation, municipal employees typically receive promises of future benefits. Motivated by the recent bankruptcy of Detroit, we develop a model of the equilibrium size of a city and use it to analyze how *pay-with-promises* schemes interact with city growth. The paper examines the circumstances under which a *death spiral* arises, where cutbacks of city services and increases in taxes lead to an exodus of residents, compounding financial distress. The model is put to work to analyze issues such as the welfare effects of having cities absorb pension risk and how unions affect the likelihood of a death spiral.

Keywords: City growth; Pay with promises; Death spiral; Defined benefit pension plans; Retiree health benefits; Detroit
JEL Classification: H20, H75, R23, R51

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*The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

1 Introduction

As part of compensation, municipal employees typically receive promises of future benefits. However, governments often do not put aside sufficient money to pay for future liabilities. For example, health benefits beyond retirement are often part of compensation packages, yet, as we discuss below, typically no money is set aside to pay for this promised benefit. A problem here is that a city might experience an adverse economic shock that causes the population to decline, and when the bill comes due for the promised benefits, relatively few people may be left to pay it. The resulting financial distress will likely be followed by some combination of cutbacks in city services or increases in city taxes. Both make the city less attractive, inducing further exodus and thereby compounding the problem. This feedback loop, where initial exodus begets further exodus, is sometimes called a *death spiral*.

The city of Detroit is bankrupt, and much of its debt stems from promises it made to compensate city employees. The term "death spiral" is regularly invoked in discussions of the crisis. For example, a program on Michigan Public Radio explained that debt based on "promises made to municipal workers" leads to a crisis where "essential services get cut . . . and business and homeowners get out of town, leaving behind a smaller and poorer population even less able to cover a city's soaring costs."[1] The emergency city manager himself (Kevyn Orr) has used the term: "We are in a death spiral."[2] Services are currently so bad in Detroit that 40 percent of streetlights are not working.[3] Police have been unable to provide basic services. The population has fallen by 26 percent since 2000, and the most recent census data show a continuing decline.

This paper provides a formal economic analysis of a model where cities pay employees with promises and the possibility of a death spiral exists. We focus on three questions. First, how do outcomes change when a city uses *pay as you go* instead of *pay with promises*? We show that death spirals will not happen under pay-as-you-go schemes. It is a simple point, but to highlight its importance, it is useful to mention an op-ed article by Paul Krugman that argued that the Detroit episode is mostly the story of a city's bad luck in the face of the declining auto industry. "For the most part the city was just an innocent victim of

[1] Interview with James Spiotto, "How do cities get in a 'death spiral,' and how can we stop it?" Michigan Radio, November 21, 2013, http://michiganradio.org/post/how-do-cities-get-death-spiral-and-how-can-we-stop-it.

[2] "Detroit to default on $2.5B debt to avoid bankruptcy, emergency manager says," Fox News, June 15, 2013, http://www.foxnews.com/us/2013/06/15/emergency-manager-detroit-wont-pay-25b-it-owes/.

[3] City of Detroit, "Proposal for Creditors," June 14, 2013, available at http://www.detroitmi.gov/EmergencyManager/Reports.aspx.

market forces."[4] Our point is that pay with promises has exacerbated the problems created by the decline of the auto industry. If Detroit had used pay as you go all along, then after it was hit by shocks that led some residents to leave, at least the tax revenue collected from the remaining residents could have been used to provide them with critical public services (like streetlights) to stem further outflow, rather than using taxes to pay for public services consumed decades previously. A related point is what happens in the model when cities abide by pay as you go in an actuarially fair expected value sense, but promise to absorb any risks of deviations from expected value. We show why this kind of insurance is costly for governments to offer, because the realization of the uncertainty feeds back into how many people end up living in the city and thereby affects the tax levels.

The second question we focus on is: What difference does it make if government workers are unionized? Note that pay-with-promises schemes in the public sector (e.g., retiree health benefits) are common for both union and nonunion workers. (This is in sharp contrast to the private sector, where most nonunion firms have switched to pay as you go.) When we look at the effect of unions, the focus is not that unionized city workers are more likely to compensated with pay with promises. Instead we hold fixed the share of compensation that is pay with promises and focus on a union's effect on overall compensation and productivity. Unions make a death spiral more likely for two reasons. First, they drive up overall compensation, which includes higher levels of pay with promises, meaning that there will be a greater overhang of legacy retirement costs. Second, unions make it more costly to provide government services to current residents, making it harder to convince residents to stay.

Our third question is: What are the implications of the analysis for the bankruptcy proceedings? In our model, allowing cities to write down legacy costs in the face of a death spiral is welfare improving. This is a blunt instrument for reducing the extent of promises. Of course, if workers were paid in cash rather than promises, there would be no need for them to show up in bankruptcy court.

The central analogy throughout this paper is that between a firm trying to attract sales for its product and a city trying to attract residents. In both cases, there is downward-sloping demand: a firm raising its price loses customers, a city raising taxes or reducing services loses residents. Furthermore, in both cases the existence of a fixed cost creates an economy of scale. For a firm, fixed costs arise for the usual textbook reasons. For a city, legacy pension and retiree health care are fixed costs. In particular, these costs depend

[4] Paul Krugman, "Detroit, the New Greece," New York Times, July 21, 2013, http://www.nytimes.com/2013/07/22/opinion/krugman-detroit-the-new-greece.html?_r=0.

on municipal employee levels from *previous* years, but do not vary with the city's current population size. Thus, the greater the current population, the more people over which to average the legacy cost. Finally, both firms and cities are subject to demand shocks. In fact, there are significant conceptual links between the literatures on the dynamics of firms and the dynamics of cities (see, e.g., Luttmer (2007) on firms and Gabaix (1999) on cities). Analogous to the way in which fixed legacy costs are a problem for a firm facing declining demand, they are also a problem for a city facing declining demand. In recent years, private sector firms have moved away from pay-with-promises schemes to pay-as-you-go schemes. Given the *qualitative* similarities between cities and firms, the economic logic for pay as you go applies to cities, just as it does to firms. Firms and cities have *quantitative* differences. We expect the demand faced by a firm to be often more elastic than the demand faced by a city. (It is easier to switch the brand of cars you buy than change where you live.) We expect the possibility of negative demand shocks to be potentially bigger for firms than cities. (The negative shock to Blockbuster of the decline of the videotape rental business obviously was more severe than the negative demand shock to Detroit.) Nevertheless, these are differences in degree, not in kind. We think the reason why pay with promises has persisted in the public sector and not the private has less to do with differences in economics and more to do with differences in institutions. (For example, state constitutions may specify pension rules for the public sector, but not the private sector.)

We turn to how our paper connects with previous literature. Although the death spiral mechanism highlighted here is intuitive, in the most basic urban economics models with free mobility across jurisdictions and equilibrium in land markets, the death spiral effect actually does not go through. This follows because in standard models, any kind of deferred tax liability is completely capitalized in land prices. (See, for example, Epple and Schipper (1981).[5]) This prevents current residents from passing off unpaid promises to later residents, because current residents themselves get charged for the services when they sell their homes. This mechanism is not at play in our model because we assume that city land is in *excess supply* with a *zero price*. Once land has zero value, there is no self-correcting mechanism, since the outcome is at a corner. We believe this is a useful abstraction for thinking about the Detroit case. For many years, Detroit has been known for having large parcels of vacant land. In fact, in 2009, extensive discussion began about the possibility of converting parts

[5]Epple and Schipper (1981) argue that the standard model implies full capitalization and then consider that there might not be full capitalization if there is imperfect information about future liabilities. See also Gyourko and Tracy (1989a, 1989b).

of Detroit back to prairie land and farmland.[6] Housing prices are astonishingly cheap. Currently, Zillow.com is reporting that the median price of homes listed for sale in the city of Detroit is $9,900.[7]

There exists an extensive public finance literature on incentive problems where voters can pass off bills for current government consumption to later generations. Inman (1982) is an early paper that focuses on the underfunding of pensions. Bassetto and Sargent (2006) and Bassetto and McGranahan (2011) are recent treatments that feature analogous externalities, where current voter decisions affect the welfare of later voters. The papers in this literature shut down the possibility of capitalization of voter decisions into land prices. Our paper has the same externality featured in this literature. The key way in which our paper is different is our focus on equilibrium mobility and the possibility of a death spiral. This kind of effect gets left out of this literature because location choices of individuals are taken as exogenous.

The concept of a death spiral has wide application throughout economics and is perhaps most commonly associated with health insurance and adverse selection. (If a pool of particularly sick people sign up for a policy, rates will have to go up, so the healthy will tend to leave the pool, making things worse.) See Buchmueller and DiNardo (2002), for example. We also note that the unfunded liabilities analyzed in this paper act as a kind of debt overhang, and so this paper is in the spirit of the large literature on how levels of debt affect economic outcomes (e.g., Myers (1977)).

The rest of the paper proceeds as follows. Section 2 presents several motivating facts. Section 3 describes the model, and Section 4 analyzes our main results. Section 5 provides concluding remarks.

2 Motivating Facts

In this section we lay out six motivating facts that we refer to as we develop and analyze the model.

- *Fact 1:* Pay with promises is a widespread practice for how cities compensate public sector workers.

[6] See "Plowing Detroit into Farmland," *Idea of the Day* (blog), *New York Times*, November 9, 2009, http://ideas.blogs.nytimes.com/2009/11/09/plowing-detroit-into-farmland/.

[7] As reported by Zillow on May 5, 2014.

A recent study, Pew Charitable Trusts (2013), focused on a sample of 61 key cities, including the largest city in each state, plus all other cities with a population of 500,000 or more. The study found that as of the 2009 fiscal year, the combined pension liability across the sample cities was \$385 billion, of which 26 percent (or \$99 billion) was not funded. The combined retiree health care liability was \$126 billion, of which 94 percent (or \$118 billion) was not funded. Note that the biggest unfunded liability is retiree health care. In fact, the majority of cities put zero money aside to pay for the future retirement benefits of current workers. This is true in particular for the city of Detroit. According to the city of Detroit's June 2013 "Proposal for Creditors," Detroit faced \$5.7 billion of retiree health care liabilities, and none of this was funded. The unfunded actuarially accrued liabilities for the pension plan were estimated to be \$3.5 billion.

- *Fact 2:* Although population growth for the country as a whole is positive, individual cities are subject to various economic shocks and some decline.

Consider the 61 key cities in the Pew Charitable Trust sample mentioned above. Over the period 1990–2010, 11 of these cities experienced population loss. These cities are listed in Table 1, sorted by population decline. The two cities at the top of this list are notable: Detroit with a 30.6 percent decline and New Orleans with a 30.8 percent decline. The story of New Orleans is Hurricane Katrina and the mass flooding that resulted in a forced exodus. There are many differences between the Detroit and New Orleans cases, but we want to particularly highlight two things. First, New Orleans is in much better shape than Detroit with regard to unfunded retiree legacy costs. According to the statistics for the 2009 fiscal year as reported in the Pew Trust study, unfunded legacy costs (pension plus retiree health care) per resident in that year are three times higher in Detroit than in New Orleans: \$7,800 per resident compared with \$2,600. (If we use the updated numbers for Detroit in the 2013 "Proposal for Creditors," legacy retirement costs in Detroit balloon to \$13,400 per resident.) Second, there is no talk of death spiral for New Orleans, which continues its post-Katrina recovery, growing by 7.1 percent between 2010 and 2012. In contrast, Detroit continues to decline. (The population declined 4 percent between June 2010 and December 2012.[8])

The Pew Trust sample selects out the largest cities. Consider next a broader sample of cities: 1990 census places with 10,000 or more in population. Out of about 3,000 such places, 26 percent experienced negative growth between 1990 and 2010, with mean growth

[8]We use the population figure for December 2012 reported in "Proposal for Creditors" because current census figures stop at July 2012.

equal to -10.2 percent among the declining cities.[9] That there exists significant dispersion in growth across cities, with some cities declining, is a well-appreciated and important fact in urban economics. (See, for example, Eaton and Eckstein (1997), Gabaix (1999), and Rossi-Hansberg and Wright (2007).) We highlight this well-known fact because of its implications for how cities finance retirement benefits. Obviously, if cities all had steady positive growth, we would not have situations in which the number of future residents might be small relative to current levels. But cities are hit by shocks and some decline. This clearly complicates schemes where future residents are supposed to make good on the promises of current residents.

The remaining facts are specific to Detroit's situation, and we pull these out from the 2013 "Proposal for Creditors," a document that we found fascinating.

- *Fact 3:* Current levels of municipal services to residents and businesses are severely inadequate.

The wording for this fact comes directly from the document. A good summary statistic is the fact reported earlier that 40 percent of the streetlights are not working. A second one is that average response time to priority one emergencies by the police *doubled* from a half hour to an hour between 2012 and 2013.

- *Fact 4:* The tax burden in Detroit is extremely high relative to neighboring jurisdictions.

Detroit has the highest property tax rate in the state. It levies an income tax of 2.4 percent, whereas every other municipality in the metropolitan area (except for one minor one) has no income tax. Detroit has a special tax on the consumption of utilities—a tax imposed by no other municipalities in Michigan.

We conclude with two facts related to unions. These facts will be relevant, as we will see in the analysis of how unions exacerbate the problems of the pay-with-promises model.

- *Fact 5:* Detroit's work force is heavily unionized. In general, unions raise wages relative to nonunion levels.

Out of 9,560 current city employees, 8,270 are represented by a union. Astonishingly, there are 47 bargaining units in Detroit (listed in Table 2). For example, the Detroit Income

[9] Here we select out the 1990 census places that we can match to the 2010 census. This is 2,911 out of 3,148 overall 1990 census places with 10,000 or more in population.

Tax Investigators Association has a bargaining unit with 15 employees, and the Field Engineers Association has a bargaining unit with 2 employees. This table provides a sense of how thoroughly unions have implanted themselves into Detroit's workforce.

Regarding pay, a large body of research has shown the positive effect of unions on pay. An article by Lee Ohanian focuses particularly on public sector workers.[10]

Next, we turn to work practices.

- *Fact 6.* Union contracts in Detroit have imposed work practices and work rules that have been associated with reductions in productivity, according to various studies. In response to the crisis, these contract terms have begun to be amended.

Collective bargaining agreements for city workers have imposed standard union work rules and work practices, thereby impeding management rights. In particular, employees have held "bumping rights" that allow them "to transfer across departments based solely on seniority (without regard to merit, relevant qualifications or experience in the new position.)"[11] There have been standard limitations on management's ability for "revising or eliminating job classifications." There have been standard limitations on management's "right to implement and modify disciplinary policies." These work rules have been found to reduce productivity. See Schmitz (2005) and the discussion in the Ohanian article cited earlier.

In response to the crisis, contract terms have been amended. In 2012, "City Employment Terms" went into effect that included changes in the above-mentioned work rules, in addition to across-the-board wage cuts and reductions in health care benefits. For example, nonpolice employees may now "be employed in any function per the city's discretion."[12] The role of the crisis in forcing the elimination of work rules is analogous to what happened in the iron ore industry, as analyzed in Schmitz (2005).

[10] Lee E. Ohanian, "America's Public Sector Union Dilemma," The American, November 26, 2011, http://www.american.com/archive/2011/november/americas-public-sector-union-dilemma.

[11] As quoted in City of Detroit, "Proposal for Creditors," p. 36.

[12] See the discussion in Mike Sandula and Marcus Wright, "City Employment Terms go into effect without Council approval," *The Michigan Citizen*, July 22, 2012, http://michigancitizen.com/city-employment-terms-go-into-effect-without-council-approval/.

3 The Model

3.1 Description of the Model

We develop a model of the population of a city, in which there is a local government that collects taxes and provides a service. Tax revenue is used to pay for the service as well as pay for any past promises made by the local government. We think of the city as being part of a larger economy, and residents locating in the city will have choices to live somewhere else. For simplicity we take the rest of the economy as given and provide a partial equilibrium analysis of one city.

We assume that individuals locating in the city have a perfectly inelastic demand for land. Moreover, we assume there is sufficient land so that it is in excess supply with zero price. The introduction argued that this is a useful abstraction for considering Detroit.

Tax revenue in the model is obtained through taxing productive activity, such as labor or business activity. Taxes create distortions. Rather than model specifics of labor supply, we model the distortions created by taxation in a direct fashion. We assume residents are identical in terms of the distortions created per tax revenue dollar collected per resident. Formally, let r be the net local tax revenue collected per resident. Let $f = C(r)$ be the full cost of collecting this revenue, including the distortion. Assume that $C(r) \geq r$ (i.e., that the full cost exceeds net revenue collected). Assume $C'(r) \geq 1$ (i.e., that the marginal full cost of one more dollar collected is greater than one). Finally, assume $C''(r) \geq 0$, which says that the full cost of taxation is convex. Equivalently, distortions increase as more tax is collected. These are standard assumptions made on how distortions relate to taxation, and the economics underlying these assumptions is well understood.

Let q denote the quality of the local government service. Assume individuals have quasi-linear utility such that dollar valuation of service quality q is given by $V(q)$, where $V(0) = 0$, $V'(q) > 0$, and $V''(q) < 0$. Define the *service-adjusted tax price* as

$$p \equiv f - V(q) = C(r) - V(q). \tag{1}$$

This begins with the full tax collected (including distortions) and subtracts out the value of the government services received.

Time is discrete. In each period t, there is a demand function $D_t(p_t)$ for being a resident in the city that will depend on the service-adjusted tax price p_t of being a resident. We assume this is strictly decreasing in p_t. This reduced form subsumes all the economic factors related to the city, aside from taxes and local government services. For example, it is meant to capture the productivity of working in the city. If the location has a comparative advantage for certain industries, like the auto industry, and if there is a national increase in demand for the auto industry, then this shifts demand $D_t(\cdot)$ out. The framework also accounts for amenities. If the city has a pleasant climate, this will be associated with higher demand. Finally, note that the demand function is strictly decreasing in the service-adjusted tax price p. We think of this as being driven by heterogeneity across individuals. Some individuals may have skills that are a good fit for the industry mix of the city; other individuals may not have these skills. Some individuals may have a preference for the particular amenity package in the city, others less so.

We note that our approach of subsuming all the economic factors, including industry productivities and amenities, into a demand function, $D_t(p_t)$, allows for a general structure. However, we want to highlight two key assumptions built into this structure. First, individuals are perfectly mobile each period. That is, when making a decision of whether to live in the city today, they only need look at the current service-adjusted tax price. They do not need to forecast the future taxes and services, because in the future when they decide where to live, decisions made today will be irrelevant. Second, the evolution of the resident demand function $D_{t+1}(p_{t+1})$ in future periods does not depend on decisions made in the current period. Thus, for example, we are ruling out cases in which the government makes investments in infrastructure that carry forward into future periods and that make the city more attractive. Including such an investment would introduce an additional state variable to keep track of, thereby complicating the analysis. To keep things simple, we abstract from this issue.

In Figure 1, we plot resident demand $D_t(p_t)$ for a particular example. The demand curve is the green line.[13] Note in the plot that the function cuts through the axis at $p = 0$ to allow for negative values of p. The service-adjusted tax price p given by (1) is negative if the value of the government service $V(q)$ more than offsets the full cost of taxation $C(r)$.

Next, we turn to the specifics of local public finance. The cost of providing the service at a particular level q scales up proportionately with the population. Think of the service as being police and fire protection or streetlights. If there are twice as many residents, there are twice as many issues for police to attend to, and twice as many streets to light. For simplicity, we assume that public sector workers are the only input in production. Let z_t

[13] In the example, $D(p) = .05 - .05p$.

be public sector labor productivity at time t, and let n_t be the total number of residents at time t. Then the required amount of public sector labor equals

$$\ell_t = \frac{q_t n_t}{z_t}. \tag{2}$$

We take wages paid to public sector workers as given. Each unit of labor employed at time t receives a current compensation w_a (i.e., when active) and a future payment w_b in the subsequent period (e.g., retirement benefits). The city can buy all the labor it demands at these prices. One way to interpret this is to think of these terms as fixed by a union contract and that there is a large pool of workers available to work at these terms.

Given the way in which the local government service is financed, each period will begin with a legacy cost x_t. This equals the retiree benefits owed based on last period's employment,

$$x_t = w_b \ell_{t-1}. \tag{3}$$

Each period is divided into two stages. In stage 1, individuals decide whether or not to live in the city, taking legacy costs x_t as given. (Note that we model this decision as being made in each period. If the individual lived in the city in the previous period, we can think of this as the individual's decision about whether to stay. If the person lived somewhere else, the decision would be whether to move here.) Let n_t denote the quantity of individuals choosing to live in the city as of the end of stage 1. Note that when deciding whether to live in the city, individuals take into account the existing legacy cost x_t. In stage 2, the n_t residents for period t collectively decide on the level q_t of government service for the period. All individuals have the same valuation for the service and face the same tax prices, so the current residents will all agree on the policy choice, assuming the current period is all that matters in collective decision making.

Conflict will arise if some individuals expect to be in the city next period, while other individuals expect to be somewhere else. The decisions in the current period affect future legacy costs, so whether one expects to be in the city long term or not affects spending preferences. To keep the analysis simple, we assume that 50 percent or more of the residences either (i) do not expect to be in the city in the next period or (ii) have discount factors of zero. In either case, only the present matters. Assuming policy is determined by majority rule, maximizing the current utility of residents is the equilibrium outcome.

3.2 Equilibrium

Here we determine equilibrium and in particular the conditions under which a death spiral will occur. We begin with the analysis of stage 2. At this point population n_t is fixed, having been determined in stage 1. Furthermore, the legacy cost x_t determined in the previous period is also fixed. The choice of service level q_t, combined with the legacy level x_t and population level n_t, together pin down the amount of net tax revenue that must be collected. This is determined from the government budget constraint,

$$n_t r_t = x_t + w_a \frac{q_t n_t}{z_t}. \tag{4}$$

The left-hand side is the total net tax revenue collected, equaling population n_t times net taxes r_t per resident. The right-hand side has legacy costs (which must be paid out of current tax revenues) in the first term and the wage bill for current workers in the second term, where we substitute in the quantity of current public employment ℓ_t given by (2). It is useful to write the government budget constraint on a per resident basis by dividing through by n_t:

$$r_t = \frac{x_t}{n_t} + w_a \frac{q_t}{z_t}. \tag{5}$$

Each current resident pays his or her share of legacy costs, plus the current cost of providing for the resident's share of the current government service. Note, if $w_b > 0$, the current service will also entail a future legacy cost. But under our assumption that at least half of the residents do not care about taxes in the next period, future legacy costs are irrelevant in decision making.

The choice of service quality maximizes a resident's current payoff, or equivalently, minimizes the service-adjusted tax cost of living in the city. That is, the service quality solves

$$p^*(n_t, x_t) \equiv \min_{q_t} C(r_t) - V(q_t)$$

for r_t satisfying (5). Let $q^*(n_t, x_t)$ be the optimal choice. Substituting in (5), we can write the service-adjusted tax price as

$$p^*(n_t, x_t) \equiv \min_{q_t} C(\frac{x_t}{n_t} + w_a \frac{q_t}{z_t}) - V(q_t). \tag{6}$$

The following is the first-order necessary condition for an interior service level $q_t > 0$,

$$C'(\frac{x_t}{n_t} + w_a \frac{q_t}{z_t})\frac{w_a}{z_t} - V'(q_t) = 0. \tag{7}$$

It is immediate that $p^*(n_t, x_t)$ strictly increases in the legacy cost x_t. Next, consider how $p^*(n_t, x_t)$ varies with n_t. In the limiting case where the legacy cost is zero, $x_t = 0$, $p^*(n_t, x_t)$ is constant in n_t. Otherwise, if $x_t > 0$, then $p^*(n_t, x_t)$ strictly decreases in n_t. Greater population makes it possible to share the burden of the legacy costs over more people. If $x_t > 0$, in the limit as n_t gets small the tax price goes to infinity,

$$\lim_{n_t \to 0} p^*(n_t, x_t) = \infty, \text{ if } x_t > 0.$$

Figure 2 illustrates $p^*(n_t, x_t)$ for a numerical example.[14] The function is illustrated by the red curves for four different values of the legacy cost. The higher the legacy cost, the higher the curve. When the legacy cost is positive, $x_t > 0$, the adjusted tax price strictly decreases in population. The curve is analogous to an average total cost curve in a product market when there are economies of scale. The legacy cost is like a fixed cost that is divided over more units, the larger the volume. Note that as the legacy costs increase, the curves not only shift up but also become more sharply downward sloping as the equivalent of fixed costs becomes more important. In the limiting case of no legacy costs, $x_t = 0$, the curve is perfectly flat. This is analogous to the case of constant average costs in product markets.

Next, we examine stage 1, where the population level is determined, given current legacy cost x_t. When making a decision about whether to become a resident in the city, an individual rationally forecasts the outcome of local government behavior in stage 2. To write down the equilibrium condition, it is useful to work with the inverse demand curve $p_t^D(n_t) = D_t^{-1}(p)$. If entry n_t is positive, it must satisfy

$$p^*(n_t, x_t) = p_t^D(n_t). \tag{8}$$

That is, at the level of entry n_t, the implied service-adjusted tax price must be consistent with the price from the inverse demand curve that sustains the entry. When there are one or more solutions to (8), let equilibrium entry $n_t^e(x_t)$ be the maximum level of all n_t satisfying

[14] In the example, $V(q) = \gamma_1 q - \frac{\gamma_2}{2}q^2$, $C(r) = \alpha_1 + \frac{\alpha_2}{2}r^2$, for $\gamma_1 = 5$, $\gamma_2 = 1$, $\alpha_1 = 1, \alpha_2 = 1$, and $w = 1$ and $z = 1$. The plot illustrates $p^*(n, x)$ for $x \in \{0, .7, 1.43, 2\}$.

(8). Otherwise, if there is no solution to (8), set $n_t^e(x_t) = 0$.

Figure 1 illustrates equilibrium in the example for different values of legacy costs. As noted above, the tax-price curve is analogous to an average total cost curve in a product market. Start at the limiting case with no legacy cost, $x_t = 0$, which takes us to the case where "average cost" is the horizontal line at $p^*(n, 0) = -4$. In this case, there is a unique intersection of the demand curve at $n^e = 1.4$, and this is the equilibrium population. Next, increase the legacy cost from $x_t = 0$ to $x_t = .7$. This shifts up the p^* curve. Demand now intersects the p^* curve at two locations. We select the largest of the two, $n^e = 1.2$. Note that equilibrium population has declined by 0.2 because of the higher legacy costs. Next, we increase the legacy cost to 1.43, at which point the demand curve is just tangent to the p^* curve, and the equilibrium population is $n^e = .75$ at this point. At any higher legacy cost, the p^* curve lies everywhere above demand, with no intersection. Zero population is the unique equilibrium, $n_t^e(x_t) = 0$, for these cases. We call this the *death spiral* outcome.

The dynamics of this model can be summarized as follows. The state at the beginning of period t is the current legacy cost x_t and demand $D_t(\cdot)$. In stage 1, entry by current residents $n_t^e(x_t)$ is determined. Then in stage 2, the service quality $q^*(n_t^e(x_t), x_t)$ and the implied taxes are determined. This pins down next period's legacy cost,

$$x_{t+1}^* = w_b \frac{q^*(n_t^e(x_t), x_t) n_t^e(x_t)}{z_t},$$

and given next period's demand $D_t(\cdot)$, the process is repeated. One additional point to make is that if there is a death spiral so no resident enters, $n_t^e(x_t) = 0$, then there is no one to pay the legacy cost. We assume that the legacy cost remains, going into next period; that is,

$$x_{t+1} = x_t, if n_t^e(x_t) = 0.$$

If demand is constant over time, there will not be entry in later periods either. In such a case, the legacy cost is like a toxic waste dump at the location that keeps people from wanting to move in.

4 Analysis of the Model

We now put the model to work to address three questions outlined in the introduction. First, how does the practice of pay with promises affect city outcomes like population, government service levels, and the welfare of residents? And relatedly, what happens when local governments make promises to assume risks in an uncertain future? Second, how do unions affect the analysis? Third, what role does bankruptcy play?

4.1 Effects of Legacy Costs

Analogous to our definition of equilibrium population $n_t^e(x_t)$, let $r_t^e(x_t)$ be the equilibrium tax revenue per resident and $q_t^e(x_t)$ be the equilibrium service quality as a function of the total legacy cost x_t.

Proposition 1. For interior values ($n_t^e(x_t) > 0$), $r_t^e(x_t)$ strictly increases in x_t while $q_t^e(x_t)$ and $n_t^e(x_t)$ strictly decrease. That is, higher legacy costs raise taxes and lower service quality and population.

Proof. It is immediate that $n_t^e(x_t)$ decreases in x_t, following our earlier claim that $p^*(n_t, x_t)$ strictly increases in x_t, combined with the assumption that $D_t(p_t)$ is strictly downward sloping. Differentiating the first-order necessary condition (7) yields

$$C'' \frac{dr_t^e}{dx_t} \frac{w_a}{z_t} - V'' \frac{dq_t^e}{dx_t} = 0.$$

Since $C'' > 0$ and $V'' < 0$, the slopes $r_t^{e\prime}(x_t)$ and $q_t^{e\prime}(x_t)$ must have opposite signs. Differentiating formula (5) for r_t, we obtain

$$\frac{dr_t^e}{dx_t} = -\frac{x_t}{n_t^2} \frac{dn_t^e}{dx_t} + \frac{1}{n_t} + \frac{w_a}{z_t} \frac{dq_t^e}{dx_t}.$$

Since $n_t^{e\prime}(x_t) < 0$, if $q_t^{e\prime}(x_t) \geq 0$, then $r_t^{e\prime}(x_t) > 0$, contradicting the fact that $r_t^{e\prime}(x_t)$ and $q_t^{e\prime}(x_t)$ have opposite signs. Hence, $q_t^{e\prime}(x_t) < 0$ and $r_t^{e\prime}(x_t) > 0$ as claimed. *Q.E.D.*

This result highlights the fundamental forces at work in the model. Suppose we begin with a given legacy level, and suppose taxes, service levels, and population levels are at their equilibrium levels. Now, from this position, suppose we raise legacy costs. If we were to maintain the current service levels and the current population, taxes will have to be raised to pay off the higher legacy cost. Recall our assumption that the marginal distortionary impact of taxation increases with taxes. With higher taxes from the higher legacy costs, the marginal cost of taxation increases, making it optimal to reduce city services. Thus taxes have increased and services have been cut, making the city less attractive, and population (up to this point held fixed) will decline. This puts further pressure on the budget, leading to another round of higher taxes and lower services, creating the feedback highlighted in the paper.

Next, we derive a formula for the effect of higher legacy costs on the welfare of current residents. Analogous to the concept of consumer surplus, we can define *resident surplus* to be the area below the demand curve for living in the city, netting out the cost of living in the city (i.e., the service-adjusted tax price). We denote resident surplus at time t, given legacy cost x_t, as $W_t(x_t)$. The formula is

$$W(x_t) = \int_0^{n_t^e(x_t)} p^D(\tilde{n})d\tilde{n} - n_t^e(x_t)p^D(n_t^e(x_t)).$$

The first term is gross resident surplus (all of the area below the demand curve). The second term is the service-adjusted tax price aggregated across residents (this is analogous to total consumer expenditure in a product market). Figure 2 illustrates resident surplus in the example, for the case where $x = .7$. A straightforward application of the envelope theorem yields

$$\frac{dW(x_t)}{dx_t} = C' \left[-1 + \varepsilon_t^n(x_t)\right], \tag{9}$$

where the *mobility elasticity* with respect to legacy costs is defined by

$$\varepsilon_t^n(x_t) \equiv \frac{x_t}{n_t}\frac{dn^e}{dx_t} < 0.$$

Holding population fixed, an increase in legacy costs has a marginal tax cost of C' (this is the -1 term). But there is an additional negative effect because a higher legacy cost reduces population, a distortion that destroys surplus. The magnitude of this effect depends on the mobility elasticity. The more mobile are residents, the bigger the negative effect of legacy costs on welfare. If demand for living in the city were perfectly inelastic, this second term would drop out. Equation (9) illustrates in a succinct way how legacy costs and mobility interact to affect welfare.

We have examined the welfare effects of a change in the *level* of legacy costs. Next, we consider what happens when legacy costs are a random variable and we change the *variance* of legacy costs but leave mean legacy costs the same. By looking at this issue, we examine the capacity of a city for absorbing risk. We are thinking here of defined benefit pension funds where governments actually do put money away to pay for future benefits, but where the government assumes the risk, in cases where there are deviations from expected value. Given the structure of the model, can cities be viewed as risk-neutral agents who can costlessly absorb risk? To answer this question, we use equation (4) to obtain the following result.

Proposition 2. A sufficient condition for $W_t(x_t)$ to be strictly concave is that $\varepsilon_t^n(x_t)$ be weakly increasing.
Proof. The proof is immediate.

The key force underlying this result is that tax distortions increase with higher taxes. This has the effect of making cities *risk averse* in legacy levels. Consider a bet where with probability π^- the legacy cost will actually be negative, $x^- < 0$. For example, suppose the city has a defined benefit pension plan with investments that have an uncertain rate of return. If investment returns are high, the pension plan is overfunded. Assume next with probability π^+ that the legacy cost is positive, $x^+ > 0$. (This corresponds to investment returns coming in low.) Finally, assume that the expected value is zero, $0 = \pi^- x^- + \pi^+ x^+$, so that in an expected value sense, the pension plan is fully funded. Under the condition imposed in Proposition 2, expected city welfare is strictly lower when the city absorbs the risk of the plan, as compared with completely off-loading the risk (e.g., through a defined contribution plan).

According to the above analysis, if city workers are risk neutral, and if residents themselves are risk neutral, it is nonetheless inefficient to pass the risks of retirement uncertainties to the city. This follows because under the condition of Proposition 2, the *derived utility function* of the city (i.e., resident surplus) is strictly concave in legacy cost. Of course, city workers are likely to be risk averse and will have a demand for some kind of insurance. However, this insurance does not necessarily need to be provided by the city. It is efficient, in this environment, for risks associated with retirement plans to be passed along to financial intermediates that have the capacity to absorb risk. That is, a city might still offer a defined benefit plan, with a locked-in formula for what retirees get each year. But the risks associated with such a plan would be absorbed by the financial intermediary, with no recourse to the city. That is, from the city's perspective, the retiree benefits included with the compensation to current workers is pay as you go, and in terms of the city's accounting would look just like a defined contribution plan.

4.2 Steady State

Next, we analyze the steady state of this model when demand is constant over time, $D_t(p) = D(p)$, and all the other model parameters are constant, such as productivity $z_t = z$. We solve for the steady state level of population, government service provision, and legacy costs. We determine how these vary when compensation is shifted away from current benefits toward promised future benefits.

In a steady state, population in the current period is the same as in the previous period, $n_t = n_{t-1} = n^\circ$, and current quality is the same as previous quality, $q_t = q_{t-1} = q^\circ$. Since $x_t = w_b \frac{n_{t-1} q_{t-1}}{z}$, we can rewrite the first-order necessary condition as

$$C'((w_a + w_b)\frac{q^\circ}{z})\frac{w_a}{z} - V'(q^\circ) = 0. \tag{10}$$

Current residents pay w_a for this period's active workers, plus the retirement benefits of last year's workers. In stationary equilibrium, the count of last year's workers equals the count of current workers. It is like a social security system in which the current residents pay part of the wage bill of last period's workers, and tomorrow's residents pay part of the wage bill of current workers.

At the margin, when current residents increase service quality, they do not pay the full marginal cost (the next generation pays a part of it). The more cost gets shifted forward, the greater the incentive to increase the current service level. To analyze this formally, let λ be the share of the wage bill that is retiree benefits (legacy costs),

$$\lambda = \frac{w_b}{w_a + w_b}. \tag{11}$$

Proposition 3. Hold fixed total wage $w_a + w_b = \bar{w}$, and let λ be the share (11) that is paid in the future period. The stationary quality $q^\circ(\bar{w}, \lambda)$ strictly increases in λ. The tax price $p^\circ(\bar{w}, \lambda)$ also strictly increases in λ.

Proof. It is immediate from (10) that $q^\circ(\bar{w}, \lambda)$ strictly increases in λ, since this lowers w_a

but leaves $w_a + w_b$ constant. Next, note that we can write

$$p^\circ(\bar{w}, \lambda) = h(q^\circ(\bar{w}, \lambda))$$

for a function $h(\cdot)$ defined by

$$h(q) \equiv C(\bar{w}\frac{q}{z}) - V(q).$$

Note that $h(q)$ is minimized at $q^\circ(\bar{w}, 0)$ and is strictly increasing in q for $q > q^\circ(\bar{w}, 0)$, using $C'' > 0$ and $V'' < 0$. Since $q^\circ(\bar{w}, \lambda)$ strictly increases in λ, $p^\circ(\bar{w}, \lambda)$ strictly increases in λ. *Q.E.D.*

Note also that as λ increases and with it $p^\circ(\bar{w}, \lambda)$, the stationary population $n^\circ(\lambda)$ necessarily decreases.

4.3 Negative Demand Shocks and Death Spirals

In this subsection we assume that the city is in a steady state with an initial demand $D^\circ(p)$. The city then experiences a negative demand shock. If the negative shock is sufficiently bad, the result is a death spiral where population collapses to zero.

Formally, assume that, on account of the demand shock, demand to live in the city is a constant fraction θ of what it would have been before, that is,

$$D^{new}(p) = \theta D^\circ(p), \text{ for } \theta < 1. \tag{12}$$

As before, we continue to assume that total wages are fixed at $w_a + w_b = \bar{w}$, and we vary the legacy cost share λ. Let n^{new} be the new equilibrium population level in the period immediately after the demand shock is realized. This period begins with the steady state legacy cost x° under the original demand. Finally, assume that there is some choke point $p^{\max} < \infty$ such that $D^\circ(p) = 0$ if and only if $p \geq p^{\max}$.

Proposition 4.

(i) If $\lambda = 0$, then $n^{new} = \theta n^\circ$ and service qualities and taxes remain at the original stationary levels, $q^{new} = q^\circ$, $r^{new} = r^\circ$.

(ii) Suppose $\lambda > 0$. There exists a cutoff $\hat{\theta} > 0$ such that if $\theta < \hat{\theta}$, we obtain the death spiral outcome where $n^{new} = 0$. If $\theta \in (\hat{\theta}, 1)$, then $0 < n^{new} < \theta n^\circ$, and $q^{new} < q^\circ$ and

$r^{new} > r^{\circ}$.

Proof

Proof of (i). This is immediate. Proof of (ii). Note that if $\lambda > 0$, the stationary legacy cost is strictly positive, $x^{\circ} > 0$. As noted earlier, $\lim_{n \to 0} p^{*}(n, x^{\circ}) = \infty$, and $D^{\circ}(p) = 0$, if $p \geq p^{\max}$. Hence,

$$\theta D(p^{*}(n, x^{\circ})) < n \tag{13}$$

must hold for all n, for small enough θ. Define $\hat{\theta} > 0$ to be the minimum value of θ such that there exists at least one level of n such that (13) does not hold. By definition of $\hat{\theta}$, if $\theta < \hat{\theta}$, then $n^{new} = 0$. If $\theta > \hat{\theta}$, then there is positive population, $n^{new} > 0$. However, after the demand shock, the period begins with legacy costs above the stationary level for the new demand. Proposition 1 then implies $n^{new} < \theta n^{\circ}$, $q^{new} < q^{\circ}$, and $r^{new} > r^{\circ}$ (noting that θn° is the new stationary population for the new demand). *Q.E.D.*

With a strict pay-as-you-go compensation practice, a proportional decrease in demand yields a proportionate decline in city size, as the city scales everything down. (Think of this as a case where the "supply" curve is perfectly horizontal.) Once we have pay with promises, proportionality falls apart. The legacy costs do not scale down. Rather, they become proportionately more burdensome the more severe the demand shock. If the demand shock is severe enough, the city collapses.

4.4 Effect of Unions

As discussed in the introduction, in the public sector, pay-with-promises compensation practices can be in found in both union and nonunion settings. So when we examine the effect of unions here, we hold fixed the extent of promises in compensation (i.e., the parameter λ in (11)). We model unions as increasing the combined compensation $\bar{w}$ over both periods. As discussed in Section 2, it is well known that unions tend to raise pay and benefits. Formally, we assume that unions shift up current pay $(1 - \lambda)\,\bar{w}$ and the future promised benefit $\lambda \bar{w}$ by the same proportion. Following Fact 6 in Section 2, we also model unions as decreasing productivity z. In summary, we assume $\bar{w}^{nonunion} < \bar{w}^{union}$ and $z^{nonunion} > z^{union}$. Otherwise, we treat a union and nonunion city as the same along every other dimension.

Our result is

Proposition 5. If stationary spending $n^{\circ} q^{\circ} \bar{w}/z$ is higher with a union, then the negative demand shock threshold $\hat{\theta}$ for triggering a death spiral is higher with a union. That is, a death spiral is more likely when workers are unionized.

Proof. It is sufficient to show that for any n, $p^*(n, x^\circ)$ shifts up in the union case. Note first that the stationary legacy cost

$$x^\circ = \lambda n^\circ q^\circ \frac{\bar{w}}{z}$$

increases with a union by assumption. Therefore, it is sufficient to show that $p^*(n, x)$ shifts up with a union for a fixed x. It is immediate from inspection of formula (6) that $p^*(n, x)$ shifts up with a higher value of $\frac{w}{z}$. *Q.E.D.*

Unions are related to whether or not a death spiral takes place for two reasons. By driving up costs, unions increase spending on public services. The first way this matters is that is when expenditures paid in promises, unions increase the stationary level of legacy costs that periods begin with. Second, unions increase the cost of providing current services, thereby contributing to an exodus from the city.

4.5 The Role of Bankruptcy

When there is a sufficiently negative demand shock (i.e., if the demand shifter θ is less than the cutoff $\hat{\theta}$), the city falls into a death spiral and collapses to zero population. The promised benefits cannot be paid, and the city has a toxic debt overhang. Following Proposition 5, a potential way to dig out of this situation is to cut overall compensation $\bar{w}$ or raise productivity z by eliminating inefficient work rules. However, if the negative demand shock is sufficiently severe, these steps might not be enough.

We consider the role of bankruptcy in the following scenario. We begin with the city in steady state at demand function $D^\circ(\cdot)$. Assume next that the city experiences a proportional demand shock θ of the form (12). Let θ be drawn from a distribution with support $\theta \in (0, 1]$, with continuous distribution density $g(\theta)$. Assume for simplicity that the new demand conditions are expected to be permanent. Following Proposition 4, there is a cutoff $\hat{\theta}$ that triggers a death spiral, and with our assumptions on the support of θ there is a positive probability of θ below the cutoff.

Suppose a bankruptcy policy exists such that if $\theta < \hat{\theta}$, legacy benefits are written down to exactly the level where the city is at the threshold of being in a death spiral. That is, legacy benefits are written down to the minimum value of x such that a positive solution $n^e > 0$ exists to the equilibrium condition,

$$p^*_{new}(n^e, x) = p^D_{new}(n^e).$$

For example, in Figure 1, suppose the legacy cost is above 1.43, meaning that we have the death spiral outcome. If the legacy cost is written down to $x = 1.43$, where demand is just tangent to the service-adjusted tax price, we obtain an equilibrium outcome with positive population. Call this threshold value $x^{haircut}(\theta)$, noting that the value will depend on the level of the demand shock. Note in particular that $x^{haircut}(\hat{\theta}) = x^*$ (i.e., there is no write-down in the limit where the shock is at the threshold triggering a death spiral). The more severe the demand shock (the lower θ), the more severe the haircut (the lower $x^{haircut}$).

In this abstract setting, introducing bankruptcy is a Pareto improvement. The workers that are owed benefits are better off getting $x^{haircut}$ than nothing. The people who choose to live in the city are better off, of course, as are the subsequent generations of residents who populate the city.

In more general models, allowing for future bankruptcy may feed back into voter decisions today. It may make voters more profligate in current spending, with the hope of off-loading debt later by declaring bankruptcy. This factor plays no role in our model because we assume from the start that voters maximize short-term benefits. Adding alternative possibilities in the future does not affect current behavior. But suppose instead we consider a more general environment where the possibility of writing off future debt affects current spending decisions. The anticipation that promised benefits might not materialize might induce workers to demand compensation that is more front-loaded (i.e., more pay as you go than pay with promises). If that happens, cities will be less vulnerable to a death spiral.

4.6 Extensions

Here, we briefly consider three ways to extend the analysis.

The first extension is to allow for discriminatory tax policies. To make our point, we refer back to Figure 1 and consider the adjusted-tax-price curve associated with the highest legacy cost (labeled $x = 2$). In this case, the adjusted-tax-price curve lies everywhere above the demand curve, and a death spiral with zero population is the only outcome. This is analogous to a case in a product market where there exists scale economies, and the average total cost curve lies everywhere above the demand curve. In a product market with these conditions, if uniform pricing is the only possibility, the product will not exist. However, if price discrimination is feasible, it might be possible to extract sufficient revenue to cover costs. In the same way, if cities can discriminate across residents, and in particular can offer lower rates to residents with lower willingness to pay to live in the city, it may be possible to avoid a death spiral even with $x = 2$. Here, we are thinking of special deals to residents with low willingness to pay as corresponding in practice to special deals offered to new businesses to add to the tax base—deals that are not offered to existing businesses.[15]

A second extension would be to introduce land and explicitly incorporate that future retirement liabilities may be capitalized in land prices. As noted in the introduction, if there is perfect capitalization, the death spiral channel highlighted here is completely eliminated. That is, land prices completely absorb future liabilities, so in this extreme case, the particular way in which employee compensation is financed does not affect residential choice. (This is a standard Ricardian equivalency point, as in Barro (1979).) An extreme case with perfect capitalization is an abstraction, just as an extreme case with zero capitalization is an abstraction. Although we have argued that the zero capitalization case is particularly useful when considering the Detroit case, in general we expect something in between these two extreme cases. As long as pension liabilities are not completely capitalized into land prices, the basic forces we highlight continue to operate, albeit in attenuated form. When a city that pays its workers in promises experiences a negative shock, its legacy costs are averaged over fewer people, making the city less attractive and thereby magnifying the effect of the original shock. Examining this dynamic in a richer model incorporating land markets, and potentially quantifying magnitudes of this channel, is an interesting topic for future research.

A third extension would be to introduce malfeasance by city administrators. In the model, it is assumed that the government acts in the interest of current residents. In reality, that might not be true. This introduces an additional advantage to *pay as you go* over *pay with promises* because it puts administrators on a shorter leash (i.e., it provides more discipline). It is possible for us to talk about malfeasance, even in the model as currently stated. Detroit is notorious for bad government; former mayor Kwame Kilpatrick was recently sentenced to 28 years in prison. In our model, we can think of poor government as a kind of negative demand shifter (in the same way that bad weather or bad industries are negative demand shifters). The advent of bad government will, of course, result in population loss as demand shifts down. The key insight of this analysis is that, if the city is also burdened with legacy

[15] The point that the ability to discriminate makes a death spiral less likely is a partial equilibrium result, holding the external environment fixed. If other cities get the ability to discriminate at the same time, the result will not necessarily be true. For more on this issue, see Holmes (1995).

costs, the negative effects of bad government will be magnified and will be more likely to result in a death spiral.

5 Concluding Remarks

The recent events in Detroit are important. Detroit is such a big city that the case is interesting in itself. Furthermore, the city is not unique in the problems it faces (although it is the most extreme instance). In this paper, we have worked through a simple model that highlights key aspects of the case. The parties involved with this case are very much aware of these key factors. Reading the 2013 "Proposal for Creditors" is almost like going through the ingredients of the model one by one. The issue here is not one of a zero-sum game, about how a fixed pie is transferred from one and given to another. Rather, the issue is about whether the city can survive, whether it can stop a death spiral fueled by abysmal services and high taxes.

If Detroit is going to survive, clearly it will have to write down some of its debt, including promised benefits to retirees. At the moment, that is where things appear to be headed. But our interest in writing this paper is less about what to do in the aftermath and more about adding to the discussion of government employee pay structures going forward. Our analysis has highlighted that (1) residents are mobile and make a choice of whether or not to live in a city and that (2) the "demand" by residents to live in a particular city is subject to shocks, similar to what happened to the auto industry in Detroit. When we consider the two of these highlights together, we see that problems arise when cities use pay-with-promises compensation schemes. When legacy costs exist, negative demand shocks get amplified on account of the mobility of residents.

As noted in the introduction, there is an analogy between a city and a firm, because a city can attract residents with low taxes and high service equality, in the same way that a firm can attract customers with low prices and high quality. And just as firms can experience demand shocks, cities can too. Considered this way, the recent bankruptcies of General Motors and the city of Detroit have much in common. Both were saddled with huge legacy costs and inefficient work practices. Both experienced negative shocks in demand. As part of restructuring, General Motors has cut back on inefficient work practices and has moved close to a pay-as-you-go model. To the extent that Detroit also moves far in this direction, it will be more resilient in the face of future shocks.

One final point we wish to emphasize from our analysis is that it raises concerns even when cities set money aside to pay the expected value of the benefits but assume the risks of deviations from expected value. We show that it is costly for cities to absorb risk. We raise the issue of why cities should be in the insurance business, as compared with financial intermediaries that might be better suited for absorbing risk.

References

Barro, Robert J. 1979. "On the Determination of the Public Debt." *Journal of Political Economy* 87(5): 940-971.

Bassetto, Marco, and Leslie McGranahan. 2011. "On the Relationship Between Mobility, Population Growth, and Capital Spending in the United States." Working Paper 16970, National Bureau of Economic Research.

Bassetto, Marco, and Thomas J. Sargent. 2006. "Politics and Efficiency of Separating Capital and Ordinary Government Budgets." *Quarterly Journal of Economics* 121(4): 1167-1210.

Buchmueller, Thomas, and John DiNardo. 2002. "Did Community Rating Induce an Adverse Selection Death Spiral? Evidence from New York, Pennsylvania, and Connecticut." *American Economic Review* 92(1): 280-294.

Eaton, Jonathan, and Zvi Eckstein. 1997. "Cities and Growth: Theory and Evidence from France and Japan." *Regional Science and Urban Economics* 27(4): 443-474.

Epple, Dennis, and Katherine Schipper. 1981. "Municipal Pension Funding: A Theory and Some Evidence." *Public Choice* 37(1): 141–178.

Gabaix, Xavier. 1999. "Zipf's Law for Cities: An Explanation." *Quarterly Journal of Economics* 114(3): 739-767.

Gyourko, Joseph, and Joseph Tracy. 1989a. "Local Public Sector Rent-Seeking and Its Impact on Local Land Values." *Regional Science and Urban Economics* 19(3): 493-516.

Gyourko, Joseph, and Joseph Tracy. 1989b. "On the Political Economy of Land Value Capitalization and Local Public Sector Rent Seeking in a Tiebout Model." *Journal of Urban Economics* 26 (2): 152-173.

Holmes, Thomas J. 1995. "Analyzing a Proposal to Ban State Tax Breaks to Businesses." *Federal Reserve Bank of Minneapolis Quarterly Review* 19(2): 29-39.

Inman, Robert P. 1982. "Public Employee Pensions and the Local Labor Budget." *Journal of Public Economics* 19(1): 49-71.

Luttmer, Erzo G.J. 2007. "Selection, Growth, and the Size Distribution of Firms." *Quarterly Journal of Economics* 122(3): 1103-1144.

Myers, Stewart C. 1977. "Determinants of Corporate Borrowing." *Journal of Financial Economics* 5(2): 147-175.

Pew Charitable Trusts. 2013. "A Widening Gap in Cities: Shortfalls in Funding for Pensions and Retiree Health Care." Report, http://www.pewtrusts.org/en/research-and-analysis/reports/0001/01/01/a-widening-gap-in-cities.

Rossi-Hansberg, Esteban, and Mark L. J. Wright. 2007. "Urban Structure and Growth." *Review of Economic Studies*, 74(2): 597-624.

Schmitz Jr., James A. 2005. "What Determines Productivity? Lessons from the Dramatic Recovery of the U.S. and Canadian Iron Ore Industries Following Their Early 1980s Crisis." *Journal of Political Economy* 113(3): 582-625.

Table 1
Sample of Key Cities with Negative Population Growth

City Name	Population Growth 1990-2010
New Orleans	-30.8
Detroit	-30.6
Birmingham	-20.2
Baltimore	-15.6
Jackson	-11.8
Charleston	-10.3
Milwaukee	-5.3
Philadelphia	-3.8
Chicago	-3.2
Wilmington	-0.9
Washington D.C.	-0.9

Source: Sample of cities obtained from Pew Charitable Trusts (2013). Growth rate of population calculated with population data from 1990 and 2010 decennial censuses.

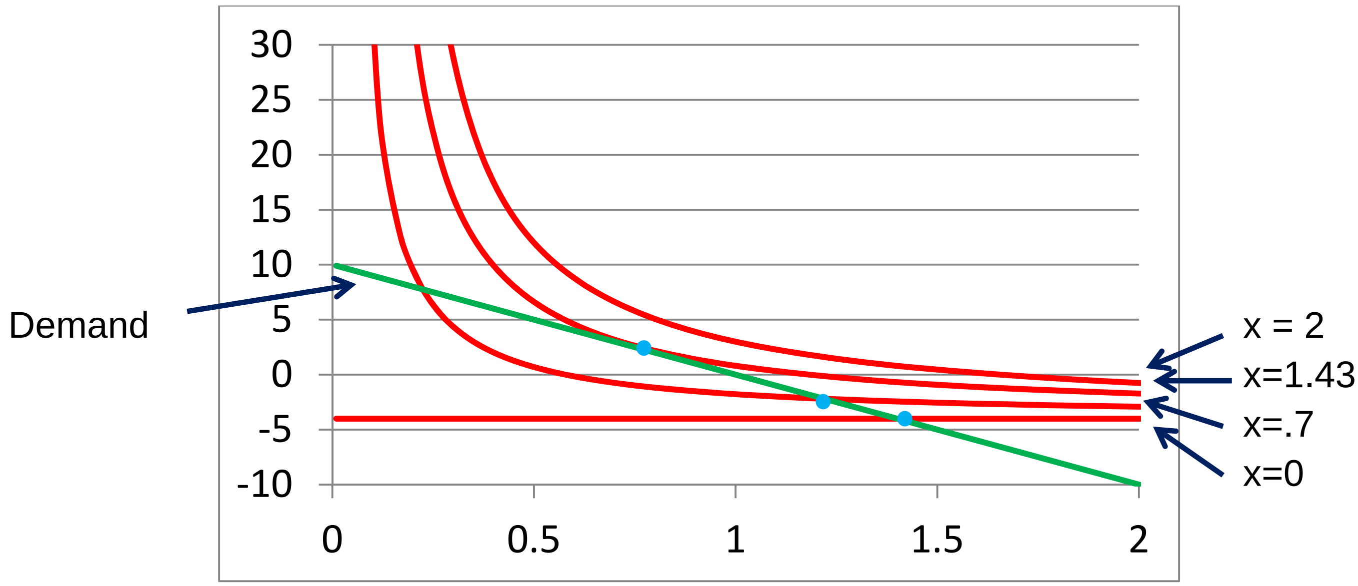
Table 2
City of Detroit Bargaining Units in 2013

Category	Name of Bargaining Unit	Number of Employees Represented
Uniform	AFSCME - ESOs	93
	Detroit Fire Fighters Ass'n	927
	Detroit Police Command Officers Ass'n	24
	Detroit Police Lieutenants and Sergeants Ass'n	530
	Detroit Police Officers Ass'n	1,991
	Emergency Medical Service Officers Ass'n (EMS)	10
	Police Officers Ass'n of Michigan (EMS)	187
Coalition and other nonuniform	AFSCME Crossing Guards	157
	AFSCME Forestry and Landscape Foreman	4
	AFSCME Motor City Seasonals	240
	AFSCME Non-Supervisory	1,656
	AFSCME Paving Foreperson's	9
	AFSCME Supervisory, Local 2394	47
	Assist. Supervisors of Street Maint. & Constr.	4
	Ass'n of Munic. Engineers (Supervisors of ADE)	15
	Ass'n of City of Detroit Supervisors	35
	Ass'n of Detroit Engineers	82
	Ass'n of Municipal Inspectors	12
	Ass'n of Prof. & Technical Employees	102
	Ass'n of Prof. Construction Inspectors	37
	Building Construction Trades – Foreman	14
	Building Construction Trades - Non-Supervisory	172
	Building Construction Trades - Special Service	26
	Buildings and Safety Inspectors – Tripartite	19
	Detroit Income Tax Investigators Ass'n	15
	Detroit License Investigators Ass'n	0
	Field Engineers Ass'n	2
	International Union of Op. Engineers - Local 324	27
	Local 324 Park Management Ass'n	7
	Local 324 Principal Clerks Unit	64
	Police Officers Labor Council (Detroit Fac. Officers)	9
	Police Officers Labor Council (Health Department)	1
	SEIU Local 517M - Non-Supervisory	5
	SEIU Local 517M – Prof. & Tech. Unit	22
	SEIU Local 517M - Supervisory	11
	Senior Accountants, Analysts & Appraisers	141

	Teamsters, Local 214	430
	UAW Local 212 (Civilian Police Investigators)	14
	UAW Local 2211 (Public Attorneys Ass'n)	37
	UAW Local 412-Unit 86 (Law Dep't Paralegals)	8
13(c) protected employees	AFSCME Non-supervisory Locals 214 & 312	312
	Amalgamated Transit Union (ATU)	622
	Building Construction Trades – Non-supervisory	4
	DOT Foreman's Ass'n	6
	International Union of Op. Engineers	2
	Supervisor Chapter of DOT Foreman's Ass'n	24
	Teamsters, Local 214	9
Total		8,270

Source: Appendix I from "Proposal for Creditors" (2013).

Figure 1
Plot of Service-Adjusted Tax Price for Various Levels of Legacy Cost
Along with Demand Curve and Resulting Equilibrium
for Numerical Example



Note: See footnotes in paper for parameters used to construct the example.

Figure 2
Resident Surplus in Example When Legacy Cost x = .7
(resident surplus shown given by triangle made up of dashed black lines)