

# **San Francisco vs. San Jose:**

The Effect of the Payroll Tax on Firms'  
Decisions to Locate

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Spring 2012

## **Abstract**

This paper examines how San Francisco's payroll tax affects commercial rental rates in San Francisco and San Jose. The agglomeration of tech firms in the two areas makes these cities partial substitutes for one another and thus both viable options for firms deciding where to locate. Twitter recently threatened to terminate plans to headquarter in San Francisco if the city did not waive the payroll tax; this has generated substantial criticism of the tax. This study combines principles from labor economics and urban economics with an adapted version of the monocentric city model so as to map the change in commercial rental rates in San Jose and San Francisco as the payroll tax increases in the latter. We see that as the tax rises, commercial rental rates rise in San Jose and fall in San Francisco. The intuition is subtle but prevalent; as the tax rises, firms face a heightened wage expenditure and are forced to either employ fewer people or vacate the city.

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## Introduction

The United States is a nation founded on growth and innovation. In the past few years, as the country has made its way through the most recent recession, one industry has emerged as a leader in growth: high technology. In the past year alone, techs jobs “outpaced the overall rate of new employment by nearly four times” and have become the new face of thriving industry (Kotkin).

The high technology industry gained massive presence in the Silicon Valley starting with Apple and Intel in the early 1970s. As the technology industry grew, the best and the brightest migrated to the valley. In the late 1990s, Google Inc. sprung up and showed the world just how prominent technology would become. Google quickly grew into one of the biggest companies around – valued at \$192 billion in 2011 (Brenner). In 2003, Google leased and developed a 26-acre headquarters in Mountain View, CA (just outside of San Jose), and in 2006 Google purchased the land for an astonishing \$319 million (Google). In 2004, Facebook.com launched, and within a year, the company had moved from Boston to the Silicon Valley. Just eight years later, Facebook now has 900 million users and a valuation that rivals Google’s (Facebook). The point is, over the last two decades, Silicon Valley has grown into the tech headquarters of the United States. The migration of these first few companies has made way for thousands of others.

As these massive tech companies have grown into some of the largest hiring agencies in the nation, the San Francisco Bay Area has been flooded with young working professionals. Naturally, young, financially stable people have migrated into the nearby metropolis: San Francisco. The draw of the city has a new wave of

tech companies targeting locations within city boundaries as company headquarters. In the last few years, massive companies such as Twitter and Salesforce have taken San Francisco by storm. The sheer presence of young, smart, tech-savvy people in San Francisco makes the city a prime location for tech and creative companies. This agglomeration effect, coupled with the activity of a city, has made San Francisco an even more valuable location than the neighboring Silicon Valley. But how much more valuable? Companies have been asking themselves this question recently for one reason – the payroll tax.

San Francisco is the only city in California that charges a payroll tax. A 1.5% payroll tax is placed on for-profit businesses that have a payroll exceeding \$250,000 annually. Currently about 8,000 companies pay it (Sabatini). The tax has some harsh critics and there is a constant fight for payroll tax reform in San Francisco. The recent economic downturn has caused a spike in unemployment resulting in an increased amount of people fighting for its removal, or at the very least, reform of the city's payroll tax.

This issue was brought to the forefront of San Francisco news in early 2011. Twitter had its eye on a massive building in the mid-Market Street area of San Francisco – an area adjacent to the financial district, yet one that has for years been plagued with issues common to low-income areas. Persistent problems of homelessness, drug use, and violence had forever made this a less than desirable location. Nevertheless, Twitter was eyeing 1355 Market Street in San Francisco. The 775,000 square foot building featured 215,000 square feet of class A office space – all of which would be occupied by Twitter. This deal would bring the building owner

a \$50 million lease contract (Dineen). Furthermore, Twitter's interest in the building sparked Shorenstein Properties' interest in purchasing the building. Shorenstein Properties is a prominent San Francisco commercial real estate fund, and they pledged that if the company bought the building they would invest \$80 million into renovation alone (Portfolio). This was big news for an area of the city that has for so long been riddled with drug deals and violent crime.

The deal came to a screeching halt, however, as Twitter began to fight the city's 1.5% payroll tax. When the City of San Francisco refused to exempt Twitter from the tax, the company began looking for office space elsewhere, and ultimately threatened to move. After some negotiation, and a vow from Twitter to "remain in San Francisco for years to come if a tax break for the company [was] approved," the city ultimately agreed to a six year 1.5% payroll tax exemption for all new hires." This agreement was also extended to businesses relocating to the mid-Market Street area," an area that "city officials have attempted to revitalize for decades" (Sabatini). The tax break secured Twitter's plans to headquarter in San Francisco, and made room for many other new tech firms to relocate to this area of the city.

Even through the recent times of economic turmoil, San Francisco has retained a fair amount of growth and prosperity. Much of this growth is attributed to high technology companies. The city has gained a reputation as a "tech center." While most of the west coast tech companies are actually located south of the city in Silicon Valley, many established tech firms have recently moved from outside of the city to within the Central Business District (CBD). Furthermore, the city of San Francisco has benefited immensely from a vast influx of startup companies. The City

has become a very logical place for young, innovative companies to locate. As a result, San Francisco has a huge draw to small start-ups and innovative tech firms. This agglomeration effect creates an added benefit to companies locating in San Francisco.

The payroll tax, however, is an added cost associated with locating a business in the city. This poses a few problems: for one, the additional cost per employee creates a disincentive for hiring new employees. When the economy is stifled and unemployment is high, cities would like to encourage hiring. Secondly, San Francisco's payroll tax charges a 1.5% tax on employees' compensation. Compensation includes salaries, bonuses, and stock options. That last one is huge for startup companies. Many start-ups compensate their employees partially (if not entirely) with equity in the company. That means that if the startup goes public, then the employees have a chance to cash in on their shares of the company that they have acquired at a fraction of the market price. The payroll tax on employees' stock options is a massive determinant in deciding whether or not to move to San Francisco (Begin).

In the past year or two, payroll tax reform has been on the tip of the tongue for many San Francisco officials. With the Twitter negotiation in 2011, it has become clear that something needs to change. San Francisco doesn't want to lose big companies because its business tax structure isn't dialed quite right. While most other California cities rely primarily on sales tax for revenue generation, businesses in San Francisco have been required to share some of that burden. The recent debate of payroll tax reform has led to a battle between a gross receipts tax and an

altered payroll tax. Proponents of the gross receipts tax argue that the payroll tax creates a disincentive for hiring and an increase in unemployment. Conversely, advocates for an adapted version of the payroll tax argue that the gross receipts tax penalizes companies for success. San Francisco Mayor, Ed Lee, has proposed a modified gross receipts tax that “breaks down businesses into six different categories,” a point that is “the key to ensuring that a switch to a gross receipts structure does not harm the city's overall economy” (Sankin). Either way, however, one thing is certain – San Francisco’s payroll tax is threatening the growth of the city, and has become a major determinant in a company’s consideration for relocating into the city. And since the payroll tax affects the number of firms located in the city of San Francisco, it likely affects commercial rental rates as well.

This paper will show, through extensive theoretical analysis, the effect of increased levels of payroll tax in San Francisco on commercial rental rates within the Central Business District (CBD) of San Francisco and San Jose. We will attempt to show that as the payroll tax rises in San Francisco, the number of firms in San Francisco decreases. This will in turn increase the number of firms in San Jose, ultimately decreasing commercial rental rates in San Francisco and increasing them in San Jose. For the purpose of this paper, San Jose represents the entirety of the Silicon Valley, and firms can only choose to locate in either San Francisco or San Jose.

## Literature Review

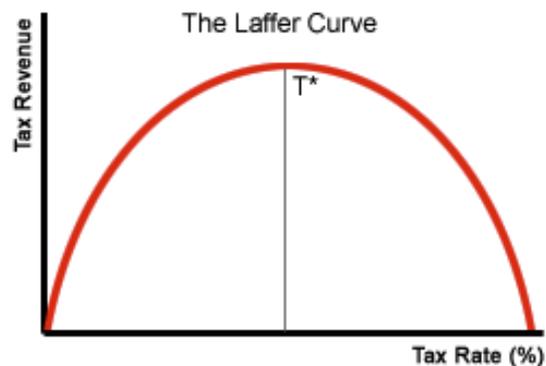
### The Business Tax:

The business tax is a tax paid at the corporate level, and it varies by city. In some cities, the business tax makes up a large portion of a city's revenue and in others it accounts for almost nothing. This tax can come in many different forms: a "Corporate Income Tax," an "Estimated Tax," a "Self-Employment Tax," a "Payroll Tax," an "Excise Tax," a "Gross Receipts Tax," and more (USA). For the purpose of this paper, we will focus on the Payroll Tax – a tax based on a firm's total wage expenditure. In California, most cities generate the majority of their revenue by sales and use tax, and no payroll tax. San Francisco's payroll tax, however, "generates approximately six percent of San Francisco yearly budget. Last year, the city's haul from the tax amounted to around \$400 million" (Sankin). However, during a recession, with the national unemployment rate hovering right around 8 percent, the payroll tax has faced quite a bit of scrutiny.

Since the tax is directly related to the wage expenditure, it creates a disincentive for hiring – something that should be avoided when dealing with a high unemployment rate. As Guillermo Cruces, an Argentinean labor economist, says, "While such taxes usually constitute an important source of government revenue, they drive a wedge between the cost of labor for a firm and the net wage of the worker, and may therefore have distortional effects on the functioning of the labor market" (Cruces). More specifically, Cruces points out that introducing the payroll tax "implies a downward shift in the labor demand schedule equivalent to the amount of the tax, and standard partial equilibrium incidence analysis states that

the extent of shifting from employers to workers depends on the elasticities of labor demand and supply” (Cruces). So, as the payroll tax increases, the demand for labor is driven down because the cost of labor is increased, hence the disincentive for hiring.

In performing an empirical analysis of any tax, we use the Laffer Curve to determine the revenue maximizing tax rate. The theory behind the Laffer Curve is simple; at a tax rate of 0% and 100%, tax revenues will be zero, and at some tax rate,  $T^*$ , tax revenues will be maximized. The revenue maximizing point on the Laffer Curve is simply found by taking the derivative of the curve, where the slope of the parabola is equal to zero. In other words, the highest point on the graph is where revenue is the highest. The Laffer Curve “illustrates the tradeoff between tax rates and the total tax revenues actually collected by the government” (Laffer Curve). The graph is as follows:



An important issue to note is that the revenue maximizing tax rate  $T^*$  is not necessarily the same as the tax rate that would be most beneficial to the jurisdiction. Let us call the tax rate most beneficial to the jurisdiction some  $T^{**}$ . The question then is: What is  $T^{**}$ ? In short, we do not know. We do know, however, that it can't be 0% and it cannot be 100% - it has to be somewhere in between. Specifically,  $T^{**}$  will

be between 0% and  $T^*$ . Each and every tax has some corresponding Laffer Curve. The payroll tax is no different. Why then is San Francisco the only city in California that has a payroll tax rate larger than zero? We do not know. However, in identifying the most beneficial tax rate,  $T^{**}$ , it is important to note some of the reasons for the Laffer effect. The extremes are obvious: A tax rate of 0% will yield \$0 in revenue no matter how many firms pay the tax. A tax rate of 100% will also yield \$0 in revenue, but for a different reason - no firms will be willing to work under a 100% tax ("Laffer Curve"). As the tax rate increases, fewer firms are willing to operate. In the case of San Francisco's Payroll tax, as the tax rate rises, firms move outside city limits so that they no longer face the tax. What effect then does this have on firms' decision to locate in the City of San Francisco? We will see.

### **Urban Economics**

Urban economics uses microeconomic analysis to study education, crime, public transit, and housing in urban areas. Through the tools of economics, we can study how cities are formed, how large they are, how spaced out they are, as well as all the activity that occurs within them. Under this large umbrella of urban microeconomics comes the monocentric city model. Developed by William Alonso, Richard Muth, and Edwin Mills, the monocentric city model helps us to understand and interpret the spatial formation of firms and households (McCann). For the purposes of our own model, we will focus only on firms.

Perhaps the most important aspect of studying urban economics is that of an urban equilibrium, which occurs when no economic agents in the city have any incentive to move to another location. This is important because in equilibrium, all agents (residents and firms) maximize utility subject to constraints. If land prices (and consequent rental rates) were any higher than those in urban equilibrium, these agents would have an incentive to move and increase utility elsewhere. For simplification purposes of the model, we will make the assumption that all firms are identical in tastes and preferences, and every firm wants to maximize its own utility (Shafran).

The basics of the model are such that in a given urban area, there is one city center or central business district (CBD). It is assumed that everyone in the city works in and commutes to the city center for work. Built into this assumption is that the further a resident or firm locates from the city center, the lower the rental rate they are willing to pay. Although these may seem to restrict the model significantly, it is possible to further apply these models to more complex cities with more than one commercial center. Everyone wants to locate as close to the CBD as possible to minimize transportation costs. Also, we can assume that agglomeration economies make locating in the center of the city even more attractive, so that firms can benefit from locating close to other firms in the same industry (Shafran).

These assumptions have become weaker as technology has progressed, however. These days, transportation is both faster and cheaper, making commuting costs not as daunting for those who choose to live outside the city center. Similarly,

the Internet has revolutionized communication, allowing back-office operations to locate outside the city center where rents are cheaper.

Nevertheless, we have decided to use the basics of the monocentric city model to test the hypothesis of our own model. The monocentric city model provides a nice foundation to work with and tweak in order to apply the model to firm behavior in a two-city situation. From the ideas set forth by Alonso, Muth, and Mills, we have added in our own justified assumptions to test our hypothesis – that an increase in the payroll tax in San Francisco will lead to firms leaving the city and entering San Jose, whose rental rates will increase.

This paper examines the effect of an increased payroll tax on commercial rental rates. More specifically, it shows how an increase in the payroll tax in San Francisco affects commercial rental rates in San Francisco as well as San Jose. By combining principles of labor economics and urban economics, we can determine the payroll tax's effect on a firm's decision whether or not to locate within the city of San Francisco.

## **The Model**

The purpose of our theoretical model is to show the change in rental rates for tech companies in San Francisco and San Jose, before and after a payroll tax increase in San Francisco. We want to show how firms react to increases in input costs and from this, where they choose to locate. This information is important to firms looking to locate in central business districts. Having an understanding for where

firms locate based on cost minimization is an essential economic concern for profit maximizing firms. Through our own theoretical model, we hope to shed light on how firms go about locating in reaction to changes in input costs, specifically a payroll tax increase.

In initial equilibrium (before any payroll tax is implemented), we expect rental rates in San Francisco to already be higher than those in San Jose. Overall, the cost of living in San Francisco is higher and so is the cost of business. A major player in this phenomenon is that of agglomeration economies. When firms of the same industry locate near each other, there is an added benefit to all firms, even for competing firms. When more firms locate together, they have a higher chance of attracting more suppliers and consumers than any single firm could alone. In addition, there is a spreading of “knowledge in the air,” where firms in the same industry can learn from those around them and progress faster (Shafran). Overall, San Francisco is a larger city than San Jose and houses more businesses, more suppliers, and more consumers. Because of San Francisco’s dominance in the Bay Area, we believe that agglomeration economies make this business hub more desirable than San Jose in initial equilibrium. Keep in mind that San Jose has agglomeration economies of its own, but we believe that San Francisco’s agglomeration economies benefit is higher than that of San Jose’s.

To begin our model, we will solve for a typical firm who wants to minimize costs in a perfectly competitive market. An ideal market situation for the economy’s overall welfare is that of perfect competition, where long run profits for firms are zero and all firms are price takers. In reality, perfect competition is not realistic.

However, we can use it as a benchmark to measure real-world markets. Through development of the model, we hope to prove that not only do agglomeration economies affect the initial rental rate in San Francisco, but that the implementation of the payroll tax will drive firms out of San Francisco and into San Jose, based on the assumption that these are the only two cities in which firms can locate. To begin, we must first identify and define the parameters we will use.

$K$  = Amount of capital     $L$  = Number of laborers     $X$  = Amount of office space (sqft)

$\rho$  = Price of capital     $\delta$  = Wage     $\alpha$  = Price of office space per sqft     $y$  = Output

$\beta$  = Price of output     $\Pi$  = Firm profits     $\alpha^{\text{SF}}$  = Rental rate in SF

$\alpha^{\text{SJ}}$  = Rental rate in SJ     $\theta$  = Added benefit of agglomeration economies

$\gamma$  = Wage + payroll tax     $\sigma$  = Wage rate in San Jose after payroll tax increase in

San Francisco

We assume the cost function of a firm at the central business district depends on three inputs to production: capital  $K$ , labor  $L$ , and office space  $X$ . Each input has its own price – price of capital, wage rate, and rental rate:

$$C(K, L, X) = \rho K + \delta L + \alpha X$$

We further assume that output is produced according to a Cobb-Douglas constant returns-to-scale production function. The Cobb-Douglas functional form is used to show the relationship between inputs to production and the output. When we assume that firms produce at constant returns to scale, we mean that doubling the inputs will lead to exactly doubled output. We show this relationship between capital and labor to output as follows:

$$y = \sqrt{KL}$$

For reasons to be discussed, we want to put the Cobb-Douglas production function in terms of just labor and output, so it can be substituted into the cost function for K:

$$K = \frac{y^2}{L}$$

When it comes to the amount of office space firms require, we make an assumption that all firms want the same square-footage per laborer. In a more complicated model, many other factors would be addressed and not all firms would be identical. For simplification purposes, we use a best-guess assumption to show the relationship between labor and office space. With that said, we will assume that the amount of office space firms need is a linear function of number of laborers, where each laborer requires about 200 square feet each. In this equation, labor and office space are perfect complements, where one factor is complemented and depended on by the other. In economic terms, perfect complements are such that a decrease in the price of one good leads to increased demand for the complementary good:

$$X = 200L$$

We now have each of our inputs to production in terms of labor. By taking our simple equations for capital, labor, and office space all in terms of labor, we can plant them back into the cost function. Now the entire cost function is in terms of labor:

$$C(L) = \rho \frac{y^2}{L} + \delta L + \alpha 200L$$

All firms want to minimize costs to production in order to maximize profits. With our parabola-shaped cost function, we want to find the point on the curve that shows the least-cost combination of inputs possible. To minimize cost, we take the

derivative our cost function (which is already in terms of labor) with respect to labor and set it equal to 0:

$$C'(L) = -\frac{\rho y^2}{L^2} + \delta + \alpha 200 = 0$$

In order to solve for the cost minimizing level of labor  $L^*$ , we simply solve through the equation for L:

$$\frac{\rho y^2}{L^2} = \delta + \alpha 200$$

$$\rho y^2 = L^2(\delta + \alpha 200)$$

$$L^2 = \frac{\rho y^2}{(\delta + \alpha 200)}$$

$$L^* = \sqrt{\frac{\rho y^2}{\delta + \alpha 200}}$$

Now that we have the cost minimizing level of labor, we must find the cost minimizing levels of both capital and office space as well. Using what we have learned about the relationship between capital, labor, and office space, we can now solve for the cost minimizing levels of capital  $K^*$  and office space  $X^*$ . For capital, we simply look back at our Cobb-Douglas constant returns to scale production function. By plugging in  $L^*$  for  $L$ , we solve through for capital, which becomes our  $K^*$  cost minimizing level of capital:

$$K^* = \frac{y^2}{L^*}$$

$$K^* = y^2 \sqrt{\frac{\delta + \alpha 200}{\rho y^2}}$$

For the cost minimizing level of office space, we follow the same approach. Since we know that office space is a function of labor, we plug in  $L^*$  into the office space formula and solve through for the cost minimizing level of office space  $X^*$ :

$$X^* = 200L^*$$

$$X^* = 200 \sqrt{\frac{\rho y^2}{\delta + \alpha 200}}$$

Now that we have both the cost minimizing levels of capital and labor, we can plug  $K^*$  and  $L^*$  back into the Cobb-Douglas production function. From this, we can prove that the cost minimizing levels of capital and labor will lead to the cost minimizing level of output for the firm:

$$y = \sqrt{KL}$$

$$y^* = \sqrt{K^*L^*}$$

$$y^* = \sqrt{y^2 \sqrt{\frac{\delta + \alpha 200}{\rho y^2}} \sqrt{\frac{\rho y^2}{\delta + \alpha 200}}}$$

This complicated-looking equation simplifies nicely to:

$$y^* = y$$

With  $y^*$  as the cost minimizing level of output, we can solve for the simple revenue function. In economics, revenue simply equals the price of the good multiplied by the quantity of the good. From our variables defined above, we know the revenue function, where  $\beta$  is the price of the good being produced and  $y^*$  is the cost minimizing level of output:

$$\text{Revenue} = \beta y^*$$

Our next task is to solve for the profit function of the firm. For simplification purposes and staying true to the principles of economics, we assume that all firms compete in a perfectly competitive market. Perfect competition simply means that no firm is large enough or has enough influence to set the price on a homogenous good in the market. All firms in perfect competition are price takers, not price setters. They take the price of the good as given, because if they were to raise their prices, consumers would take their business elsewhere. Built into this assumption is that all firms in perfectly competitive markets earn zero long-run profits in equilibrium. As firms compete to undercut competitors and gain more consumer business, they lower their prices to the point where revenue is exactly equal to cost. At any price below this level, the firm would be earning a loss and would go out of business. From this, we know that profits are equal to revenue minus costs of production, which we also know must be equal to zero in perfectly competitive long run equilibrium:

$$\pi = \beta y^* - (\rho K^* + \delta L^* + \alpha X^*) = 0$$

Now we know that revenue is equal to costs, where the output and each input are in their cost minimizing forms:

$$\beta y^* = \rho K^* + \delta L^* + \alpha X^*$$

$$\beta y = \rho y^2 \sqrt{\frac{\delta + \alpha 200}{\rho y^2}} + \delta \sqrt{\frac{\rho y^2}{\delta + \alpha 200}} + \alpha 200 \sqrt{\frac{\rho y^2}{\delta + \alpha 200}}$$

Simplified:

$$\beta y = 2y\sqrt{\rho(\delta + \alpha 200)}$$

We now have a market-wide simplified cost-revenue function for firms. Using our simplified profit function, we can manipulate it to solve for changing rental rates as the effect of changing labor costs in each city. Once the payroll tax is implemented, we know that this will affect the cost of labor for firms most directly. For simplification purposes, and to show exactly how rental rates in the two cities are affected, we will assume that  $\delta^{SJ} = \delta^{SF} = \delta$ , and  $\rho^{SJ} = \rho^{SF} = \rho$ . This means that in both San Francisco and San Jose, the rental rate and the price of capital are equal. This is obviously not realistic, but for theoretical purposes we feel that it is necessary to properly show how agglomeration economies directly affect rental rates in both cities. Let us solve through the model to find San Jose's rental rate  $\alpha = \alpha^{SJ}$ . To do this, we go back to the industry-wide cost-revenue function and solve through for  $\alpha^{SJ}$ , holding all other factors constant:

$$\beta y = 2y\sqrt{\rho(\delta + \alpha^{SJ}200)}$$

$$\beta^2 = 4(\rho\delta + \rho\alpha^{SJ}200)$$

$$\beta^2 = 4\rho\delta + \rho\alpha^{SJ}800$$

$$\rho\alpha^{SJ}800 = \beta^2 - 4\rho\delta$$

$$\alpha^{SJ} = \frac{\beta^2}{\rho 800} - \frac{\delta}{200}$$

We now have San Jose's rental rate in equilibrium. In modeling San Francisco's profit function, we need to take a bit of a different approach. In equilibrium, we assume that all price points in San Francisco are higher than those in San Jose. Basically, the cost of running business is higher due to what we call agglomeration economies, where there is some additional benefit to locating in a city center where

many firms in the same industry locate. There is, in a sense, knowledge in the air, and all similar companies will benefit. Both San Francisco and San Jose experience these benefits, but we believe that San Francisco's are higher due to its larger size, number of firms, and economic output. To show the additional benefit of agglomeration economies, we add the parameter  $\theta > 0$  to San Francisco's benefit function, with the hopes of showing how initially, San Francisco's rental rate is higher than San Jose's. Keep in mind, this is all before we even discuss the addition of the payroll tax in San Francisco. Since the cost function is not altered yet, we pick up where we left off with the same cost function as San Jose. The difference is that we add the parameter  $\theta$  to San Francisco's revenue function to show its added benefit and solve through the profit function for San Francisco's wage rate  $\alpha^{SF}$ :

$$\beta y + \theta = 2y\sqrt{\rho(\delta + \alpha^{SF}200)}$$

$$\alpha^{SF} = \frac{\beta^2}{\rho 800} - \frac{\delta}{200} + \left( \frac{\beta\theta}{400\rho y} + \frac{\theta^2}{800\rho y^2} \right)$$

In comparing initial rental rates in San Francisco and San Jose, we see that rental rates in San Francisco are greater than those in San Jose by exactly:

$$\frac{\beta\theta}{400\rho y} + \frac{\theta^2}{800\rho y^2}$$

By adding in the additional parameter for agglomeration economies, we can see exactly how much rental rates in San Francisco are affected in our simplified model. Now that we have set up our models in both San Francisco and San Jose, highlighting the differences in rental rates through agglomeration economies, we can now introduce the proposed payroll tax in San Francisco. The payroll tax will have some additional cost to labor by the term  $t$ , where  $(\delta + t) > \delta$ . Simply put, the cost of

labor to firms is higher after the implementation of the payroll tax. For simplification purposes, we will create a new parameter,  $\gamma = \delta + t$ , to denote the increased cost of labor to firms in San Francisco. Now we solve through San Francisco's cost function all the way through to rental rates to show the effect of an added cost to labor. In this case, all we do is replace each  $\delta$  with  $\gamma$  at every stage, beginning with the cost function to firms:

$$C(K, L, X) = \rho K + \gamma L + \alpha X$$

$$C(L) = \rho \frac{y^2}{L} + \gamma L + \alpha 200L$$

$$C'(L) = -\frac{\rho y^2}{L^2} + \gamma + \alpha 200 = 0$$

$$\frac{\rho y^2}{L^2} = \gamma + \alpha 200$$

$$\rho y^2 = L^2(\gamma + \alpha 200)$$

$$L^2 = \frac{\rho y^2}{(\gamma + \alpha 200)}$$

$$L^* = \sqrt{\frac{\rho y^2}{\gamma + \alpha 200}}$$

Again, we use what we know about the relationship between labor, capital, and office space to solve for the optimal levels of capital  $K^*$  and office space  $X^*$ :

$$K^* = y^2 \sqrt{\frac{\gamma + \alpha 200}{\rho y^2}}$$

$$X^* = 200 \sqrt{\frac{\rho y^2}{\gamma + \alpha 200}}$$

Recreating the revenue function:

$$y^* = \sqrt{K^*L^*}$$

$$y^* = \sqrt{y^2 \sqrt{\frac{\gamma + \alpha 200}{\rho y^2}} \sqrt{\frac{\rho y^2}{\gamma + \alpha 200}}}$$

$$y^* = y$$

$$\text{Revenue} = \beta y^*$$

Assuming all firms compete in a perfectly competitive market, economic profits in long run equilibrium are equal to zero:

$$\pi = \beta y^* - (\rho K^* + \gamma L^* + \alpha X^*) = 0$$

$$\beta y^* = \rho K^* + \gamma L^* + \alpha X^*$$

$$\beta y + \theta = 2y\sqrt{\rho(\gamma + \alpha^{SF} 200)}$$

Solving for the rental rate:

$$\alpha^{SF} = \frac{\beta^2}{\rho 800} - \frac{\gamma}{200} + \left( \frac{\beta \theta}{400 \rho y} + \frac{\theta^2}{800 \rho y^2} \right)$$

Since  $\gamma > \delta$  and the equations for  $\alpha^{SF}$  before and after the payroll tax are identical *except* for the substitution of  $\gamma$  for  $\delta$ , we know that as a result of the payroll tax in San Francisco, rental rates have dropped. The simple explanation for this is that firms have exited the city, driving down the demand for office space. In our two-city model, firms can either locate in San Francisco or in San Jose. When firms move out of San Francisco, the number of firms (and therefore labor) increases in San Jose. As more and more laborers move into San Jose, the wage rate will fall since the supply of laborers has exceeded the demand. We can assume that the decrease in the wage rate in San Jose (due to an increased supply of labor) is directly related to the increased number of firms migrating to San Jose and the increased demand for

office space. By adding a parameter  $\sigma$  ( $\sigma < \delta$ ), we can show through the model that a decreased wage rate will increase San Jose's rental rate relative to before the payroll tax in San Francisco. To do this, all we have to do is go through San Jose's profit and rental rate functions and substitute  $\sigma$  for  $\delta$ . As we saw before with the implementation of the payroll tax in San Francisco, the profit function will be exactly the same except for the new substituted variable. To save time, we will skip ahead to the profit function and solve for San Jose's new rental rate. For San Jose's profit function after the payroll tax, we get:

$$\beta y = 2y\sqrt{\rho(\sigma + \alpha^{SJ}200)}$$

Solving for the new rental rate:

$$\beta^2 = 4(\rho\sigma + \rho\alpha^{SJ}200)$$

$$\beta^2 = 4\rho\sigma + \rho\alpha^{SJ}800$$

$$\rho\alpha^{SJ}800 = \beta^2 - 4\rho\sigma$$

$$\alpha^{SJ} = \frac{\beta^2}{\rho 800} - \frac{\sigma}{200}$$

Since we know that  $\sigma < \delta$ , we have proven that San Jose's rental rate is now higher than it was before the implementation of the payroll tax in San Francisco.

### Discussion of the Model

This model uses the basics of the monocentric city model to explain many empirical observations. Such observations include: higher agglomeration economies lead to higher costs of living and higher rental rates, and that in a long-run urban equilibrium, all economic agents enjoy maximized utility with no incentives to leave

the city. Maximized utility is used in theory to understand the behavior of individuals who want to make themselves as well off as possible. In the real world, the situation is not as cut-and-dry as in a theoretical model, since there are countless other factors that affect one's well-being. For the sake of the model, we assume that the idea of maximizing utility is ideal for individuals and firms who are interested in making themselves better off.

We were correct in our assumption that initial rental rates in San Francisco were higher than those in San Jose at least partially due to the extra benefit of higher agglomeration economies. It is important to note that our theoretical model has some major restrictions and cannot possibly tell us exactly how much higher rental rates are in San Francisco – or if the rise is due to agglomeration economies alone. For the sake of the model, we feel that this assumption is justified. In the real world, we would expect many factors to influence the difference in rental rates between the two cities, factors that we cannot account for in our simple model. The addition of the parameter  $\theta$  led us to find that as benefits rose in San Francisco, so did its rental rate as compared to San Jose. Since San Francisco enjoyed higher benefits but at higher costs, the net benefit was equaled out to zero, as was the case in San Jose. Because of this property of perfectly competitive markets, firms do not have any incentive to leave their respective cities.

However, once the payroll tax is implemented in San Francisco, now costs are higher with constant benefits. The reaction of firms is to relocate where they will find lower costs, so they will move to San Jose where there is no payroll tax. For the tech industry in Northern California, the two major hubs to locate are San Francisco

and San Jose, which represents the Silicon Valley. Under our simplified model, we are assuming that San Francisco and San Jose are the only two possible cities in which firms can locate. The idea is that since their benefits will not change, they need to do what they can to lower their input costs. In this case, they want to enjoy a lower rental rate. As more and more firms demand cheaper office buildings, demand for buildings will rise in San Jose, raising the rental rate there. Because of the law of supply and demand, we know that as more people or firms demand a good or location, the price of that good or location will rise. It is important to note that the rental rate curves for both San Jose and San Francisco are convex due to the factor substitution between capital and labor for firms. At a certain point, the rental rate will rise until there is no longer any incentive to move into San Jose, and net benefits will once again be equal to zero. We would expect to find that the overall number of firms located in San Francisco has decreased, while that number has increased in San Jose.

When the payroll tax increases in San Francisco, we can view firms as having three options: leaving the city to avoid the tax (by moving to San Jose), staying in the city and paying the tax, or going out of business completely. When firms decide to move into San Jose to operate, the demand for labor in San Jose will increase. However, these firms will bring along their workers with them, so the supply of labor will increase at a similar rate. Overall, this would keep the wage rate relatively constant. For the firms that had to go out of business in San Francisco, there are laborers who would subsequently be out of jobs. Since the demand for labor has decreased in San Francisco due to the payroll tax increase, these laborers will seek

out employment in the only other city they can: San Jose. The effect on the labor market in San Jose will be an additional rightward shift in the supply of labor, driving down the wage rate relative to before a payroll tax increase. By showing a drop in wage rates in San Jose, we have proven in our theoretical model that new rental rates have risen. Since benefits are left unchanged, any decrease in an input cost will translate to an increase in another input cost to keep profits at zero in equilibrium. Through the assumptions of our theoretical model, we cannot perfectly predict what would happen to the labor markets in both San Francisco and San Jose in the “real world,” but we believe that this provides a fair representation for our theoretical purposes.

Based on the model we created, we have shown that the added benefit of agglomeration economies to San Franciscan firms raises the initial rental rate in equilibrium. Also, the implementation of the payroll tax in San Francisco shown in our model suggests that as the cost of the labor input increases, rental rates decrease to signify firms exiting the city. Lastly, as firms move out of San Francisco into San Jose, rental rates rise as more firms demand office space in the city that provides lower labor costs to firms.

## **Conclusion**

In the last few years, San Francisco has emerged as a capital for high technology. The city’s draw for high tech firms now rivals that of the well-established Silicon Valley. Until recently, only the Silicon Valley offered the benefit

of an agglomeration economy – tech firms benefiting from locating near other tech firms. Now, however, San Francisco offers an equally strong agglomeration of high tech firms. Furthermore, since tech firms employ mainly the bright and youthful, San Francisco offers the additional perks of an urban metropolis – something that is very attractive to young, financially well-off people.

Recently, though, San Francisco's 1.5 percent payroll tax has faced some harsh criticism. When Twitter threatened to cancel its plans to headquarter in San Francisco if the tax was not waived, people really began to question the validity of the city's business tax. Since San Francisco is the only city in California that charges a payroll tax, firms must consider this additional cost of locating within the city. For tech firms, Silicon Valley (represented in the paper by San Jose) is a viable alternative.

This paper uses an adapted version of the monocentric city model to show how San Francisco's payroll tax affects commercial rental rates in both San Francisco and San Jose. We find that as the payroll tax in San Francisco increases, the commercial rental rate falls in San Francisco and rises in San Jose. This is due to a decrease in the demand for labor in San Francisco, and eventual migration of firms to San Jose. Eventually, holding all else constant, at some level of payroll tax, the rental rates in San Francisco and San Jose will equalize.

It is important to recognize, however, that this model is based on many assumptions, and may not correctly model how the payroll tax affects commercial rental rates in the real world. There are many other factors that firms consider when deciding on where to locate their company. Additionally, in reality, firms are

not limited to San Francisco or San Jose – they can locate anywhere. Also, there are high costs of moving a company – costs that are not built into our model. However, the model we’ve developed does offer some insight into the interaction between the payroll tax and commercial rental rates.

Since this paper does not offer an empirical analysis of San Francisco’s payroll tax on surrounding commercial rental rates, it does not offer a specific payroll tax rate that would increase efficiency. Its benefit to public policy makers then is the theoretical intuition behind the interaction of the payroll tax and commercial rental rates. Policy makers must choose a payroll tax rate that satisfies a balance between high tax revenues and a high number of firms staying in San Francisco after the tax. The perfect balance is unknown.

Ultimately, by combining principles from labor economics and urban economics with an adapted version of the monocentric city model, this paper proves that as the payroll tax increases in San Francisco, the commercial rental rate falls in San Francisco and rises in San Jose. Only time will tell exactly how many firms will leave the city for a less tax-burdened location, but the intuition is clear: higher taxes on the wage expenditure depress the demand for labor and ultimately cause firms to flee in search of a less stifling environment.

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