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WAGES IN CALIFORNIA DURING THE GOLD RUSH

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ABSTRACT

The California Gold Rush was an unexpected shock of tremendous size that prompted the costly re-allocation of labor to a frontier region. Using newly-collected archival data, this paper presents estimates of nominal and real wages in Gold Rush California. Consistent with a simple dynamic model of labor market adjustment, real wages rose sharply during the early years of the Rush (1848-1852), declined abruptly following massive in-migration, and then remained constant for the remainder of the 1850s. However, although the Rush itself was a transitory event, it left California wages permanently higher. Estimates based on census data suggest that the supply of labor into Gold Rush California was about half as elastic as the supply of labor into Alaska during the Pipeline Era.

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Other than the Civil War, few events in nineteenth century American history capture the imagination like the California Gold Rush.[1] The initial discovery of gold in 1848 and the subsequent Rush of people into the state were the subject of innumerable newspaper articles, diaries, and related contemporary accounts. The Gold Rush was an epic adventure for the "argonauts" and "49-Niner's" who took part in it. It has also been a lightening rod for historians seeking metaphors for the grand issues of frontier development -- the callous exploitation of native peoples and natural resources, the slow and uncertain development of orderly government from chaos, the haphazard taming of the American West (Goodman 1994).

This paper, too, is about the Gold Rush, but not as cultural metaphor. Rather, I view the Gold Rush as an unusual natural experiment for judging the ability of the antebellum American economy to respond to geographically-localized demand "shocks" --in this case, a massive one that required the significant and costly re-allocation of labor (and other mobile factors) from distant locations to a virtually unpopulated region. Compared with the Gold Rush, the allocative challenges posed to the ante-bellum economy by trend growth in non-farm labor demand, or by the ebb and flow of shifts in supply and demand within local labor markets were routine (Margo 1997, chs. 5-6). Although it is abundantly obvious from the historical record that labor migrated to California in response to the gold discovery, the precise time path of wages and labor supply has never been documented. Such information is vital, however, to judging how well the ante-bellum economy coped with a shock of such magnitude compared with, for example, a similar shock during a later period in American history.

Following a brief recounting of the history of the California Gold Rush, the paper develops a simple, static model of wage determination in a gold rush economy. The model provides good intuition into the impact of the gold discovery of on wages, but it cannot -- by design -- describe wage dynamics. Accordingly, I consider several possible dynamic paths for wages, in light of what is known about adjustment (eg. migration) costs from the historical literature. I argue that the most likely path was an initial rise in wages spread over the first few years of the Rush, followed by a steep decline.

Next, I use a sample of payrolls of civilian employees at U.S. Army forts in California to estimate nominal wage series for common labor-teamsters, artisans, and clerks. A price deflator is constructed from Thomas Senior Berry's (1984) compilation of wholesale prices. The time path of real wages revealed by the estimates is quite consistent with the stylized model of wage determination. Real wages rose very sharply between 1848 and 1851, fell abruptly in 1852, and then remained roughly constant for the remainder of the decade. Although it was, by definition, a purely transitory shock, the Gold Rush appears to have left a permanent imprint on California wage levels. I argue that the permanent effect occurred because, as a result of the Rush, California became integrated into the economy of the northern United States, where wages were relatively high.

The paper concludes by examining the wage elasticity of labor supply into Gold Rush California over various periods years (for example, 1848-1852), using labor quantities computed from the federal censuses and the state census of 1852. The estimates range between two and three, suggesting a relatively elastic response. However, labor supply into Gold Rush California was less elastic than into Alaska during the Pipeline era (1973 to 1976), a testament to more than a century's worth of improvements in the spatial efficiency of North American labor markets.

1. The California Gold Rush

Although its coastal regions had been explored in the sixteenth century, the true origins of California lie in Spain's acquisition of French claims to the vast Louisiana territory following the end of the Seven Years' War in Europe in 1763. Charles III of Spain subsequently sent the adventurer Jose de Galvez to push Spanish settlement north of Mexico, in the hope of preventing English encroachment into Mexico and its rich mining region. Galvez invented the "mission" -- in reality, a colonizing institution whose purpose was to Christianize native populations, settle them into agriculture, and ultimately create an inter-linked set of local economies (Coman 1912 vol. 1; Lavender 1976, p. 18)

The mission approach was largely successful in Baja California and southern Arizona, but rebellious Indians blocked its extension into Alta (Upper) California. Galvez appointed Fray Junipero Serra to head an expedition to Alta California, along with the governor of Baja, Gaspar de Portola. After great hardship, they established a "presidio" (fort) at San Diego, and later at Monterey (Lavender 1976, pp. 19-22). By 1772, there were five missions and two presidios. The number of missions grew slowly but steadily. San Francisco was added in 1776, Santa Barbara in 1782 (Coman 1912 vol. 1; Lotchin 1974).

Life at the missions was hard. Mortality was extremely high, agricultural productivity was frequently low, and there were periodic skirmishes with Indians. Nonetheless, by the early nineteenth century missions were taking root, particularly in the South, where ranching and some wheat farming flourished (Coman 1912 vol. 1, pp. 145-155; Lavender 1976, pp. 24-27).

The missions began to fall somewhat out of favor in the early nineteenth century. Conflict arose over access to land in California, and anti-clerical sentiment erupted in Mexico. By the mid-1830s mission land was placed under secular control, and a series of private land grants was initiated. Fueled by cheap labor, primarily native American, Southern California ranches had become highly profitable in cattle production, yet the standard of living of the "working class" was miserable (Coman 1912 vol. 1, pp. 172-189; Lavender 1976, pp. 29-31).

Throughout its colonization of California, Mexico faced serious difficulties keeping out interlopers. American trappers and fur traders appeared in Alta California as early as 1800 (Coman 1912 vol 1., p. 160). Furs were traded for manufactures brought by Boston shippers who stopped in Monterey and San Francisco on the way to China (Coman 1912 vol. 1, p. 163-164). Russia established Fort Ross in Alta California (illegally, but with the full knowledge of the Mexican government), and kept it in operation until 1841. By 1832 there was a well-travelled trade route between Sante Fe and Mission San Gabriel (Coman 1912 vol. 2, p. 214). In addition, there was a steady stream of Americans who became Mexican citizens and (promised) to practice Catholicism in exchange for land grants. By the early 1840s they were joined by small bands of settlers (Coman 1912 vol. 2, pp. 228-241; Lavender 1987, pp. 34, 37-40).

Slowly but inexorably disputes occurred between the settlers and the Mexican government. In June of 1846 a group of settlers staged the so-called "Bear Flag" revolt (near present-day Sonoma) with the aid of Charles Fremont of the U.S. Corps of Topographical Engineers and sixty troops under his command (Coman 1912 vol. 2, p. 246; Caughey 1948, pp. 4-5). Word soon came that the United States was at war with Mexico. The mission at Monterey was seized by Commodore John D. Sloat. Additional troops and naval units were despatched from the Army of the

West, the Mormon Battalion, and a contingent of poor artisan volunteers from New York who had been promised free passage for themselves (and their tools) if they stayed in California at the end of their tour of duty (Caughey 1948, pp. 4-5; Lavender 1976, p. 49). By mid-1846, the U.S. navy occupied all usable ports in California (Lavender 1976, p. 46).

The Mexican War came to a formal end with the signing of the Treaty of Guadalupe Hidalgo on February 2, 1848. In exchange for 15 million dollars and the forgiveness of 3.3 million in American claims against the Mexican government, Mexico ceded California, New Mexico, Utah, Nevada, Arizona, and disputed parts of Texas to the United States (Lavender 1976, p. 4).

Ironically, the treaty was signed two weeks after -- and without knowledge of -- the discovery of gold that marked the formal beginning of the Gold Rush.[2] James Marshall, a carpenter working for John Sutter (a recipient of a land grant from Mexico), happened upon a pea-sized pellet of gold near the American River. At first, Marshall and Sutter attempt to keep knowledge of the discovery a secret, but were unable to prevent the information from leaking. Teamsters and other travellers delivered the news to various settlements on the way to San Francisco (Coman 1912 vol. 2, p. 256; Lavender 1976, pp. 50-51). The local response was rapid and extreme. According to an eyewitness, when the news reached Monterey in early May:

> The blacksmith dropped his hammer, the carpenter his plane, the mason his trowel, the farmer his sickle, the baker his loaf, and the tapster his bottle. All were off for the mines ... [there is] only a community of women left, and a gang of prisoners (quoted in Lavender 1976, p. 51).

According to a June 1 report, half of San Francisco's population (at that time, between 800 and 1,000) had left for the mines, and fully three-quarters were gone by the middle of the month (Coman 1912 vol. 2, p. 257; Caughey 1948, p. 21).

The local labor supply was supplemented by in-migration. The schooner Louisa relayed the news to Honolulu, and other ships, bound for points north and south, did the same (Caughey 1948, p. 23). Migrants poured in from Oregon (according to some reports, half of the male population), and from Hawaii, Mexico, Chile, Peru, China, and Australia (Lavender 1975, p. 53; Caughey 1948, p. 23-24; Marks 1994, p. 24).

The news took somewhat longer to reach the East. The first report, a letter in the New York Times, appeared in mid-August, and the New Orleans Daily Picayune reported the discovery in mid-September (Caughey 1948, pp. 34-35). Clearly exaggerated, the early newspaper reports prompted disbelief, but official army accounts led President Polk to make a formal announcement in December (Lavender 1976, p. 55). Transportation companies quickly formed; handbooks for "argonauts", such as G.G. Foster's The Gold Regions of California, were hastily written; and an avalanche of migrants followed (Caughey 1948, pp. 51-55).

Although the specific routes varied enormously, there were three general ways to get to California. One way was by ship around Cape Horn, the chief disadvantages being the time cost (from three to eight months), and the hazards of shipwreck and on-board disease. A theoretically quicker route (six to eight weeks) was to take a ship to the Isthmus of Panama, travel overland to the Pacific, and then board another ship for San Francisco. Until Cornelius Vanderbilt build a railroad across the Isthmus (for which the fare was $25.00), the trip through Panama was extremely arduous (Coman 1912 vol. 2, p. 261).

By far the most popular route, however, was overland (Caughey 1948, p. 95). Migrants banded together in groups leaving from various points in Midwest, such as St. Louis. Because travel during winter was next to impossible, most tried to leave in April or May at the latest, the goal being to arrive in the gold fields by September. Overland migrants battled impassable terrain, bad weather, wagon damage, hunger, thirst, disease (cholera epidemics were frequent), and the occasional Indian attack (Caughey 1948, pp. 58-60; Davis 1989).

Aside from the time costs, the money costs of migration were very high by the standards of the time. Fares on the Panama Route (depending on the port) ranged from $100 to $300, for example, and the money costs of equipping an overland trip were in a similar range (Caughey 1948, p. 66; Davis 1989, p. 137). Despite the high time and money costs of transport, the numbers of migrants are impressive -- an estimated 90,000 in 1849, and perhaps another 80,000 in 1850 (Lavender 1976).

Though all surely had gold on their minds, not everyone became (or remained) a miner for long. Many migrants realized that profits could be made transporting consumer goods to the mines, and set up makeshift stores under tents at mining camps (Coman 1912 vol. 2, pp. 274-276; Lavender 1976, p. 75). Others sought to make their fortune in commerce, real estate, banking, or other services in rapidly growing San Francisco (see below). By 1860, there were 217 miners for every 1,000 people in the state, compared with 624 per 1,000 in 1850 (DeBow 1853, p. 976; Kennedy 1864, p. 35).[3]

The immediate consequence of the in-migration was rapid population growth. Estimates of the population on the eve of the Gold Rush, excluding non-Christianized Indians, range from 3,000 to 8,000 (Coman 1912 vol. 2, p. 217; Caughey 1948, p. 2; Lavender 1976, p. 15). The 1850 federal census put the population at 93,000, 77 percent of whom were males between the ages of 15 to 40 (DeBow 1853, pp. 966-68; Kennedy 1862, p. 130).[4] By 1852 the population had grown to approximately 264,000 (DeBow 1853, p. 982).

Although most scholars date the end of the Rush sometime in the early 1850s (although some date the end as late as 1857, see Marks 1994, p. 31), population growth fueled by in-migration continued through the rest of the decade, albeit at a slower pace. By 1860 the population had risen to 380,000, but the adult male (ages 15 to 40) share had fallen to 49 percent, indicating a substantial shift in the demographic composition of the in-migrants towards more permanent settlers (Kennedy 1862, p. 131; Kennedy 1864, pp. 26-27).

Some of the most spectacular growth occurred in San Francisco. In 1844 the population of "Yeuba Buena" (the Mexican name for San Francisco) was about 50. A town census in 1847 showed the hamlet had grown to 459 souls over the preceding three years, and the population doubled again the next year, presumably due to the establishment of the quartermaster's depot and the military presence left over from the Mexican War (Lotchin 1974, p. 8). Then, as a consequence of the Gold Rush, the population exploded. By 1852, San Francisco housed 34,000 inhabitants, and by 1860, 56,000 (Lotchin 1974, p. 102). External trade expanded swiftly, being surpassed during the decade only by New York, Boston, and New Orleans (Lotchin 1974, p. 45).

San Francisco's extraordinary growth can be attributed to two factors--direct access to the Pacific (that is, its port facilities) and proximity to the gold fields (Coman 1912 vol. 2, p. 277; Lotchin 1974, pp. 5-6). Prospective '49 Niners' who took the sea route arrived at San Francisco, where they sought to buy supplies for the final leg of their journey and equipment for the mines, thereby creating a booming market in pans, shovels, and Indian baskets (Coman 1912 vol.

2, p. 279; Caughey 1948, p. 32). Miners journeyed back to the city with their treasure, where they attempted to purchase goods and services. During the early years most goods, including food, were imported into San Francisco -- including, evidently, turtle meat from the Galapagos Islands. Eventually the imports gave way to locally-produced agricultural and manufactured goods, much of which was marketed in San Francisco (Lotchin 1974, pp. 10, 47; Caughey 1948, pp. 210-213).

In the case of certain locally-produced services, the shock to demand was sometimes so great that the line between traded and non-traded goods blurred. The cost of washing, it is said, rose so rapidly after 1848 than clothes and restaurant linens were sent by clipper ship to Hawaii or even China for cleaning (Marks 1994, pp. 197-199).[5]

After the initial deposits near Sutter's Mill were exhausted, miners spread out over a 35,000 square mile area looking for more gold (Coman 1912 vol. 2, pp. 266-268; Caughey 1948, pp. 52-54). Some of the gold -- so-called "placer deposits" -- was so easy to find that it could be literally scooped out of streams, but other deposits were harder to locate and retrieve.

By the second half of 1849, the easy gold nearby the "Motherlode" was gone, and more complex methods -- use of cradles, "long toms", and sluice boxes -- had to be employed. Miners discovered that mercury ("quicksilver") bonded with gold in an amalgam, which could then be cleaned. Quicksilver was readily available, due to the discovery of rich deposits near San Jose (Lavender 1976, p. 62).

Although placer mining remained the most significant type until late in the 1850s, alternatives soon appeared. Quartz harbored goal, and quartz mining grew after extensive deposits were discovered near Mariposa in 1849. Stamp mills, use of hydraulics, and "tunnelling" were other important innovations. By comparison with placer mining, however, the required capital investments (and associated risks) were substantial, beyond the means of ordinary miners. Mining companies formed, and entrepreneurs competed with placer mining to hire laborers (Caughey 1948, pp. 249-266).

Wherever significant deposits were found, mining camps soon followed. By the standards of the day -- and certainly by those of the twentieth century-- living conditions in the camps were extraordinarily bad. Aside from mining, there was little to do, and alcoholism was rampant. So, too, was disease and malnutrition, as sanitary conditions were horrible, in part due to the environmental damage caused by the mining operations and the close (and crude) living quarters. Nonetheless, the camps thrived, as miners fashioned crude local government and rudimentary procedures for enforcing their stakes (Caughey 1948; Lavender 1976, pp. 65-66; Marks 1994).

Once the gold ran out, the camps were abandoned as quickly as they had been established (Caughey 1948, p. 267). Those still bitten by the gold bug moved onto the next strike or sometimes, gold rushes elsewhere (for example, Australia; see Caughey 1948, p. 293). The less successful sought to return home but, hampered by high migration costs, frequently settled for employment in agriculture or in the burgeoning non-farm sector in and around San Francisco (Caughey 1948; Lotchin 1974; Lavender 1976).

The Gold Rush had important political consequences. By far the most important was California's early admittance into the Union in 1850, thereby bypassing territorial status. A consitutional convention was called in 1849, and the constitution was overwhelmingly ratified by popular vote on November 13. From the standpoint of statehood, the critical issue was slavery: Californians desired admittance as a free state, which upset the delicate political balance in Washington. The furor was abated by the Compromise of 1850, by which California was admitted as a free state, while New Mexico and Utah were organized as territories which could then decide for themselves to be slave or free (Lavender 1976, pp. 69-71).

2. Wage Determination in a Gold Rush Economy

This section presents a simple, static model of wage determination in a gold rush economy. The model is not novel -- it is a standard "Dutch Disease" framework, and a similar version of it has been used to analyze another historical gold rush, that of Australia in the early 1850s (Maddock and McLean 1984).[6] The prediction for nominal wages in the model economy is straightforward: nominal wages rise after the discovery of gold, and then decline once labor supply fully adjusts to the spatial shock to labor demand. The comparative static path followed by real wages may be more complex, but it is likely, too, that real wages rise initially and then fall.

As noted earlier, the static model is useful for developing intuition about the wage impact of a gold rush, but it cannot describe the dynamic path followed by wages. I therefore augment the static model with a brief discussion of likely dynamic paths for wages.

As a point of departure, imagine a pre-"gold rush" economy, by definition one in which population is small and perhaps highly scattered. There are N individuals, each of whom is endowed with equal shares (1/N) of the economy's known stocks of gold. N is fixed in the short run, but may vary in the long run. Initially, I assume that known stocks of gold are very small; however, as the number of individuals changes I maintain the assumption that each is endowed with 1/N of the stock of gold.[7] The total capital stock, K, is fixed in the short run, and each individual has an equal share (1/N) of it.

Individuals maximize utility, which is defined over the consumption of a locally-produced good, X, whose price is p_x, and an imported good, Z. The traded good is supplied from a "settled" economy removed by distance from the gold rush economy. The supply of the traded good is assumed to be perfectly elastic at price p_z.

Individuals allocate their available labor supply (L) between the production of the local good or towards gold production. Once produced, the local good can either be consumed or sold at the price p_x. Gold, as well, can be used to purchase either X or Z, but it cannot be consumed. Gold is the numeraire commodity.[8]

The maximization problem is

$$\max_{X,Z,L_x} U(X, Z)$$

s.t.

$$p_x X + p_z Z = p_x F(L_x, K) + g(L - L_x)S$$

where F is the production function for X, K is capital, and S is the endowment of gold ore. The function g is a <u>harvesting</u> function, which converts the stock of ore into a flow (g) available for export or purchase of X. I assume that both F and g are concave; $g(0)S = 0$ (if no labor is allocated towards gold harvesting, gold output is zero); and $g<=1$ for any value of $L_g = L - L_x$.

The first order conditions are straightforward. Consumption of X and Z should be efficient

$$U_x/U_z = p_x/p_z$$

as should the allocation of labor between the production of the local good and harvesting of gold

$$p_x F_L = g'S$$

That is, labor is allocated to equalize the value of the marginal product in both production activities.

I model a "gold rush" as an increase in the economy's known stock of ore (S). An increase in S shifts the harvesting function outward but, because $g(0)S = 0$, the shift is not a parallel one. As Figure 1 illustrates, at a fixed level of $p_x F_L$ (= w, the nominal wage), individuals will want to allocate more labor to gold harvesting (at point B) than in the initial equilibrium (point A). In the aggregate, the increase in L_g produces an inward shift in the supply of labor to the production of the local good, causing w to rise.

Gold has value in exchange, however, and so the aggregate demands for X and Z may change. As long as X is a normal good, the demand for X will increase, leading to an increase in the demand for labor in the local goods sector. The increase in the demand for labor in the local sector further drives up w and, as well, p_x. Define the "real wage" to be $w/h(p_x,p_z)$, where h is a "cost of living" function.[9] Because p_z is exogenous (the supply of Z is perfectly elastic), whether the real wage rises or falls depends on w/p_x. However, $w/p_x = F_L$. If, in the new (short run) equilibrium, the quantity of labor demanded in the local sector declines, F_L will increase, as so will the real wage.[10]

In the long run, mobile factors (labor and capital) may flow in (or out) of the gold rush economy, provided that, in the new equilibrium, factor returns are sufficiently high to justify costs of adjustment (see below). Labor may be attracted into the gold rush economy because real income is higher after the discovery of gold. Capital may be attracted, especially because in-migration of labor will increase the aggregate demand for X.[11] For modelling purposes, I assume that any new labor shares in the endowment of gold equally with the initial residents. Consequently, from the standpoint of individuals, S falls, and the harvesting function shifts inward. The inward shift reduces the incentive to mine gold, thereby increasing the incentive to supply labor to the local goods sector. If the labor supply effect dominates relative to any shift in product demand, w will fall, as will w/p_x (and thus, so will the real wage).

Figure 2 illustrates the key ideas of the model in a simple "supply-demand" diagram. The curves AA' and BB' are short-run "labor supply curves" -- that is, they are collections of equilibrium values of w/p_x and L_g for any given size shock to labor demand in gold production. Point C represents the initial equilibrium -- that is, at point C the shock is normalized to be zero. The real wage rises in the short run to $(w/p_x)_1$, but falls in the long run to $(w/p_x)_2$. The line CD in Figure 2 can be thought of as the "long run supply of labor" into the gold rush economy, and later I attempt to measure its elasticity.

The static model captures certain essential features of wage determination in a gold rush economy, but there is no question that the model is highly stylized in several respects. For example, an interior solution to the first order conditions implies that the representative individual allocates time to gold production and to production of the local good. While miners often did just that over the course of the year (because mining was seasonal; see below and Lotchin 1974), others clearly specialized their labor supply. Specialization does not alter the basic thrust of the model, as long as some individuals were at the margin of shifting into gold production just prior to the gold discovery.[12]

Second, it was necessary to prospect for gold and establish a claim before harvesting it. Both activities had uncertain returns. Incorporating uncertainty into the model can be done in the following manner. Assume that time spent in gold harvesting is divided into two activities: prospecting (which includes establishing claims) and harvesting. By allocating L_p to prospecting, each individual can increase the probability $p(L_p)$ that he will find gold (I assume that $p''<0$). Expected income from gold harvesting is now

$$p(L_p)g(L - L_x - L_p)S$$

There are now two ways to model a gold rush -- either an increase in S or an upward shift in p_i for any given level of L_p. Either way, the gold rush increases the expected marginal product of labor in gold harvesting, and the remainder of the static analysis is unchanged.

Wage Dynamics

By design, the static model does not describe the dynamics of wage adjustment in the gold rush economy. To describe the dynamics of wage adjustment, it is necessary to specify expectations about the occurrence and duration of the shock, and about adjustment costs. In what follows, I shall assume that the gold rush is a transitory shock -- that is, the probability that its duration will continue indefinitely is known, in advance, to be zero.[13] For the moment, I assume that labor is the mobile factor and, therefore, ignore capital in- (or out) migration.

Figure 3 illustrates the dynamic path for w if individuals had perfect foresight that the gold rush would begin at date t, last until date t', and adjustment costs were convex.[14] By "adjustment costs" I refer to all costs associated with changing the allocation of labor from its initial pre-gold rush equilibrium, and changing it back again once the gold rush has ended.

With perfect foresight and convex adjustment costs, it would be rational for labor to begin migrating into the economy before the gold rush, in order to avoid incurring high marginal adjustment costs at date t. Similarly, it would make sense for labor supply to decline just before the end of the rush, again to avoid high marginal adjustment costs. Therefore, w falls somewhat before date t, but the influx of labor before t will generally not be sufficient to prevent w from rising above its "long-run" equilibrium value for a while after t (Carrington 1996).[15] Analogously, some excess labor will remain after t', causing a temporary slump in wages.

Figure 4 illustrates the dynamic path for w if t and t' are uncertain, but adjustment costs are zero. By "uncertain", I mean that no individual knows exactly when (or even if) a gold rush will occur. Once the shock occurs, however, information that a rush has begun is instantaneously available to all individuals. Similarly, the end of the rush is uncertain, but once it has occurred, this information is immediately transmitted.

If adjustment costs were zero, then uncertainty over t and t' has no economic consequence. Labor simply adjusts once the shock occurs, and wages move immediately to their new equilibrium value, returning to their original level when the rush is over.

On apriori grounds, Figures 3 and 4 are ill-equipped to describe actual wage dynamics during the California Gold Rush, because individuals did not have perfect foresight about the discovery of gold or the duration of the Rush and, based on the discussion in section 1, adjustment costs were obviously non-zero. Further, as section 1 showed, the discovery of gold took place in stages -- that is, the shock was spread through time.

Figure 5 hypothesizes an historically-relevant dynamic path for wage adjustment. In Figure 5, I assume that gold discoveries take place in sequence; discoveries are unanticipated, as is the end of the rush; and adjustment costs are convex. Consequently, wages rise in a step-like fashion; there is no "building-in-advance" (that is, no migration before date t); and all of the added labor is surplus once the rush ends, so that wages fall abruptly.

If data on w were available continuously (that is, at all dates in the diagram) it would be possible to observe the step-like pattern. However, if the wage data are "time-averaged" -- for example, annual averages, which is the case here (see section 3) -- the narrow line drawn through the steps would be observed path for w.

Up to this point I have ignored capital mobility. Allowing for capital mobility (with adjustment costs) might alter dramatically the wage adjustment path (Taylor 1996). For example, if adjustment costs for capital were uniformly lower than for labor, the initial jumps in wages (for example, at date t in Figure 3) would be greater. If the capital were of the "putty-clay" variety-- capital costs are mostly sunk once the capital is in place -- relatively high wages might be sustained for some after the rush is over. However, wages would still eventually return back to their initial equilibrium, unless it was profitable for some other reason (see section 3) to continue to invest in the gold rush economy after the rush was over.

More complex dynamic models could also be fashioned by considering exactly how factor supply, particularly labor, would change in the short versus long run, and by incorporating inflationary feedback. For example, individuals in the gold rush economy have strong incentives to intertemporally substitute leisure. They expand effort in the short run following the gold discovery, believing that the additional work will be temporary and having accumulated gold (a store of value), they will enjoy more leisure and possibly consumption in the future. However, given that daily and weekly hours of work in the late 1840s and early 1850s were already quite high -- for example, a ten hour day and sixty hour work week was not uncommon -- it is unclear that increases in hours at either intensive margin offered much scope for substitution (Lothin 1974, p. 86). But the same may not have been true of annual hours, in light of the widespread seasonality of labor demand during the ante-bellum period (Engerman and Goldin 1991).

The particular timing of migration could also be analyzed in a more complex model. Because gold harvesting was uncertain, individuals in the settled economy might prefer to wait rather than migrate immediately, because the majority of costs of migration were sunk once incurred.[16] However, the very concept of a "rush" suggests that prospective migrants believed that the easy gold would be gone unless they got there first.[17] Given high migration costs, if the first effect dominates, labor supply would be inelastic in the short run, but might become abruptly elastic. If the second effect dominates, however, labor will rush in, but migration will eventually tail off.

By "inflationary feedback" I mean a non-neutral impact of changes in the stock of gold on wages and prices. Because the country was on a metallic standard, there is little doubt that the California Gold Rush raised the general price level. Goldin and Margo (1992) argue that, in the long run, there is no evidence against "long-run neutrality" for the ante-bellum period -- in the long run, shocks to the money supply had no permanent effects on relative prices, including real wages. But the issue here is not the general price level; it is whether increases in the stock of gold affected local prices more quickly than wages -- that is, whether nominal wages in California were sticky in the short run. Certainly the anecdotal evidence on prices during the Gold Rush is suggestive of the possibility of inflationary feedback (Caughey 1948, p. 203; Marks 1994, p. 177).[18] Unfortunately, the wage and price data at hand are not really sufficient to determine whether inflationary feedback occurred, and I ignore it in my empirical analysis.[19]

3. Data and Estimation of Wage Indices

Traditional accounts of the California Gold Rush provide anecdotal evidence on wages and prices, but nothing sufficient to construct a continuous nominal or real wage index. To construct wage indices, I make use of a sample of wages paid to civilians hired at U.S. army installations in California. The source, The Reports of Persons and Articles Hired, has been used previously to construct nominal wage series for the four standard census regions, but not for a frontier area like California (Margo and Villaflor, 1987; Goldin and Margo 1992). The army built and maintained forts in California, however, throughout the 1840s and 1850s and, like forts elsewhere in the country, quartermasters hired civilians to perform various tasks.

Table 1 shows the distribution of wage observations in the sample of California forts, by occupation, fort location, and time period. The sample covers the period 1847 to 1860 and, as in Goldin and Margo (1992), is restricted to common labor (including teamsters), skilled artisans, and white collar workers. Approximately 45 percent of the wage observations pertain to forts located in modern-day Northern or Central California (that is, in direct proximity to the gold), with the remainder from forts in Southern California or scattered "field" locations. About 90 percent of the observations pertain to common labor-teamsters, or to artisans. Overall, there are approximately 5,600 wage observations.

As pointed out by Margo and Villaflor (1987), the major issue in using data from the Reports is that the army was not a competitive firm and wages for its civilian workers might have diverged from going rates in the local labor market.

Comparisons between the Reports sample and purely civilian sources suggest that any such bias is very small (Margo 1997, ch. 2; Margo and Villaflor 1987). Unfortunately, such comparisons are difficult to make with the California sample because of the paucity of direct evidence.

However, what is known from the anecdotal evidence is that, post-Gold Rush, nominal wages in California were far higher than elsewhere in the country. Thus, my wage estimates for California forts should substantially exceed those for other census regions using the same data source. As is clear from the estimates presented in the Appendix (see below, and the Appendix for a discussion of how the estimates are constructed), wages at California forts were far higher than at forts elsewhere in the country. For example, my estimate of the daily wage for unskilled labor in California in 1850 is \$3.78, compared with Margo's (1997, ch.2) estimate of \$0.83 in the Midwest.[20] In what follows, therefore, I assume that the Reports sample faithfully replicates wage trends in the purely civilian economy in California.

Hedonic Wage Regressions

Like the sample analyzed by Margo and Villafor (1987) for the rest of the United States, the California sample is not large enough to construct occupation-specific wage series for each fort. Few forts hired the same type of labor every year, and the numbers of observations across forts varies over time. Analysis of the data that ignored such composition effects would be misleading. Thus, following Margo and Villaflor (1987), I estimate hedonic wage regressions of the form:

$$\ln w = X\beta + \epsilon$$

where ln w is the log of the nominal daily wage; X is a vector of independent variables; the ß's are the hedonic coefficients; and ϵ is the error term.

Monthly wages are converted to daily wages by dividing by 26 days per month. The independent variables are dummy variables for fort location; characteristics of the worker or job associated with especially high or low wages; whether the worker was hired on a monthly basis; season of the year; and time period. Separate regressions are estimated for the three occupation groups (common labor-teamsters, artisans, and white collar workers). The regressions are reported in Table 2.

The cross-sectional patterns revealed by the regression coefficients are informative about the ante-bellum labor market in California. Seasonal variation in wages, for example, is broadly consistent with what is known about seasonal fluctuations in labor demand. Summer was the slack season in gold production, and miners flocked back to San Francisco to find alternative employment (Lotchin 1974, p. 49) while "every spring [the miners] drifted back to the diffings, leaving a shortage of labor" (Coman 1912 vol. 2, p. 316). The seasonal lull in gold production helps explain why wages of common labor were relatively low in the summer. It also helps the bump in artisanal wages during the summer and fall, prime seasons for construction activity in California. Rapid growth in population placed enormous strains on the construction sector, which needed to bid skilled labor away from the mines (Lotchin 1974, p. 50). This may also explain why carpenters were highly paid in California relative to other artisans, at least compared with elsewhere in the U.S. (see Margo 1997, ch. 3; and Coman 1912 vol. 2, p. 317). The choice to enter the white collar market was not a seasonal one and, therefore, it is not surprising to find an absence of seasonality in clerical wages.

Despite generally high labor demand during the period, there is still evidence of a premium for unemployment risk, as artisans hired on a monthly basis generally earned a lower per diem wage than those hired daily. There is no evidence of a daily wage premium for clerks -- indeed, the negative effect revealed by the regression suggests a lower level of skill not revealed by the job description in the payrolls.

Regional patterns in money wages in California bear resemblance to those occurring elsewhere. Skill differentials were generally lower in the North than in the South (Margo and Villaflor 1987). Evidently the same latitudinal pattern carried over to the far West. However, the negative effect of a Southern California location may also be proxying for unobserved ethnic or racial (native American background). Hispanics, who were concentrated in Southern California, earned much less than other workers, and Hispanic status may very well be under-reported in the data.[21]

Time-Series Patterns

I use the hedonic coefficients to estimate annual series of nominal daily wages for the three occupational categories. These series are shown in the Appendix. The procedure to calculate the series is the same as in Margo (1992). Weights for producing the series are also shown in the Appendix .

Consistent with the theoretical model, nominal wages rose sharply for all three groups from 1847 to 1850. Wages peaked in 1851, declining sharply afterwards, and then fluctuating for the rest of the 1850s.

The annual movements are broadly consistent with qualitative accounts of the Rush. Scattered estimates of wages in newspaper articles suggest that wages rose after the gold discoveries, and remained roughly stable (relative to 1849 levels) until 1853 (Lotchin 1974, p. 86). My series clearly capture the steep initial rise and the 1853 decline, but also suggest that the peak occurred somewhat earlier.[22] A business cycle downturn is known to have occurred in 1855 following a local banking panic and this, too, apparently left its imprint in wage levels (Coman 1912 vol. 2, pp. 285-287; Lotchin 1974, pp. 51, 59).

To convert the nominal wage series into real wage indices it is necessary to deflate by a price index. Data to construct a price deflator for ante-bellum California are extremely scanty, but it is possible to use Thomas Senior Berry's (1984) compilation of prices from newspapers to construct a rough price deflator.[23]

The price deflator is shown in Figure 6. Although there are severe fluctuations at annual frequencies, the general pattern is of a rise in prices during the early years of the Rush, followed by an abrupt (and apparently persistent) decline. The short-run increase in prices is consistent with anecdotal evidence of goods shortages during the initial phase of the Rush, while the subsequent decline in prices presumably reflects the dramatic growth of the commercial sector in and around San Francisco (Caughey 1948; Lothin 1974).[24]

The real wage series, formed by dividing the nominal wage estimates (indexed at 100 in 1860) by the price deflator, are shown in Figure 7. The series should be viewed with caution for three reasons. The price data refer solely to wholesale prices and no provision is made for housing prices. It is entirely possible that including housing prices would dampen the short-run and long-run increases in real wages evident in the indices. The range of goods included in the price deflator is somewhat limited compared with the price deflators used in other studies of antebellum real wages. Berry's price data refers exclusively to non-Southern California locations.[25] Below I show, however, that the substantive findings are similar if the wage sample is restricted to non-Southern California forts.

Despite these problems, the real wage indices essentially mimic the patterns evidence in the nominal wage series. Real wages increased sharply between 1847 and 1851, fell abruptly in 1852, and then fluctuated around more or less constant means for the remainder of the decade. Because the indices are equally scaled to 100 in 1860, it is apparent from their initial values that real wages rose more for common labor than for artisans or clerks. This suggests that skilled labor may have been somewhat less mobile to and from the mines than unskilled labor, although it is clear from the indices that no occupational group was immune from the effects of the Rush. In absolute terms, the average annual rates of increase are some of the highest ever recorded in American history over spans of at least a decade. For example, the annual growth rate for common labor between 1847 and 1860 is near 10 percent. Growth rates of real wages for artisans and white collar workers were lower -- respectively 4 and 3 percent per year -- but still very impressive.

Annual and secular movements in real wages suggest several findings. Real (and for that matter, nominal) wages were clearly flexible during the Gold Rush; accepting the indices at face value, there can be no question that the gold discovery markedly affected wages. Although the fit is not perfect, the time series patterns resemble certain features of the diagram of wage dynamics in Figure 5. Real wages climbed as if in response to a "triangular" shock (that is, a sequence of gold discoveries), and then declined sharply when the shock ended.

However, what is <u>not</u> consistent with Figure 5 is the finding for all three occupations that real wages were far higher in 1860 than in 1847. Figure 5 was drawn on the assumption that the Gold Rush was a transitory shock, yet the rush appears to have left wages permanently higher in California.

Implicit in Figure 5 was an assumption that real wages in the settled economy were constant over the period of the Rush. The real wage indices produced by Margo (1997, ch. 3) indicate that, elsewhere in the country, real wages were higher in 1860 than in 1847. Thus, real wages could have trended upwards in California because they were trending upwards elsewhere.

However, rates of growth of real wages in both the North and South, while positive over the 1847 to 1860 period, were far lower than in California (see Margo 1997, ch. 3). In addition, data from the published 1860 Census of Social Statistics suggests that real wages in California on the eve of the Civil War were similar to average levels elsewhere in the country.[26] If so, the clear implication is that real wages in California just before the Rush were well below real wages elsewhere.

That real wages in California <u>circa</u> 1847 may have been very low by Northern standards is less paradoxical than it seems. To the extent that pre-Gold Rush California was part of any regional economy at all, it was part of the Mexican economy, the economy of coastal points north, and to a much lesser extent, Central and South America.[27] As pointed out in Section 1, initial in-migrants came from these locations and, for them, the returns to migration, on average, were surely positive. By the time large labor flows had arrived from the eastern and midwestern United States (the early 1850s), real wages arguably exceeded those elsewhere in the United States, providing the appropriate price signal.[28]

But the Gold Rush could not have left a permanent imprint on real wages unless there had been a substantial inflow of factors complementary to labor <u>and</u> continued incentive to invest capital. The Yukon Gold Rush of the late 1890s did not transform southern Alaska into the equivalent of California. What became clear to the migrants (and to many miners who struck gold early in the Rush) was that California was rich in many ways, specifically in agricultural resources. As noted in Section 1, California bypassed territorial status, and statehood presumably reduced the risk of permanent settlement. The rapid, sustained growth of San Francisco is *prima facie* evidence of agglomeration effects and a widening of the market for locally-produced agricultural (and manufacturing) goods (Coman 1912 vol. 2, pp. 291-314; Caughey 1984; Lotchin 1974).

Evidence of an inflow of complementary factors is both indirect and direct. Indirect evidence of an inflow of complementary factors can be gleaned from Berry (1984) who, in addition to wholesale prices, collected a series of monthly interest rates in San Francisco. Figure 8 shows the ratio of Berry's series to my nominal wage series for common labor (both series are indexed to 100 in 1860). The wage-rental ratio in 1850 was well below 100, suggesting extreme initial scarcity of capital (Coman 1912 vol. 2, p. 307). Translating the trend in the ratio during the 1850s into equivalent movements along a factor-price frontier, the implication is that the capital-labor ratio must have been rising.

While the extraordinary high interest rates that prevailed in San Francisco in the early 1850s may have been partly due to unusually high risk, direct evidence of capital accumulation can be found in the city (and state's) active participation in issuing of bonds in the New York and London financial markets (Lotchin 1974, pp. 60-61, 77). Additional direct evidence comes from the 1850 and 1860 censuses. In 1850, per capita investment in manufacturing capital was negligible but, by 1860, had grown in real terms over the decade by 1,204 percent. Investments in land-clearing and complementary factors raised wheat output per acre by 463 percent over the decade.[29] Capital in-flows sustained the transitory wage effects of the Gold Rush, initializing the long process by which California became an integral part of the American economy.

Do Wages in Northern California Follow a Different Trend?

One objection to the wage indices is that the hedonic regression restricts the trend in wages to be the same at both Southern and non-Southern California forts, yet the Gold Rush was a Northern (and Central) California phenomenon. Although the sample sizes preclude estimating reliable non-Southern California wage series for artisans and white collar workers, there are sufficient observations to estimate a common labor series.

A real wage series for common labor-teamsters at non-Southern California forts, constructed in the same manner as the other series, is shown in Figure 9. Although the level is somewhat different, the general time pattern is the same as the all-California series.[30] Wages rose sharply after 1847, peaked in 1851, fell sharply in 1852, and then remained roughly constant for the rest of the decade. Evidently the labor market within California was sufficiently well-integrated that the localized shock of the gold discovery in Northern California was easily transmitted to Southern California.

4. The Elasticity of Labor Supply

In this section I present estimates of the elasticity of labor supply into California during the Gold Rush. In terms of Figure 2, the idea is to measure the elasticity implied by the line segment CD. I compare my elasticity estimates to Carrington's (1996) estimates for labor supply into Alaska during the building of the Alaska pipeline in the mid-1970s.

The elasticity of labor supply is

$$\epsilon_{wL} = d(\ln L)/d(\ln w)$$

where "d" indicates the difference operator. I identify d(ln L) with estimates of the change in employment of miners between various years. Under the maintained assumption that Figure 2 is accurate, d(ln w) can be measured either by the change in miner or non-miner wages. Qualitative evidence is consistent with this assumption. According to a San Francisco merchant, "[w]ages ... are ruled by the price of mines ... if a man can get in the mines $5.00 a day he is unwilling to work [here] for less" (quoted in Lotchin 1974, p. 85). For the purposes of the calculation, therefore, I use the real wage series for common labor. The construction of the elasticity estimates is described in the Appendix, and the estimates themselves are shown in Table 3.

The estimates are all positive and, with one exception, fall between two and three, indicating a highly elastic response.[31] The one exception is the calculation from the peak of the real wage series (in the early 1850s) to 1860, which gives an estimate of about unity. As already noted, there were strong incentives for miners to remain in California once they were there, and these incentives would tend to reduce the elasticity of labor supply, as viewed (with hindsight) from the end of the period.[32]

Measured against the experience of the Alaska pipeline, labor supply into Gold Rush California appears much less elastic. For various reasons direct comparisons between the Gold Rush and Pipeline labor supply are difficult to make, but on the assumption that daily hours was not the primary intensive margin during the Rush, a relevant comparison is Carrington's (1996) estimate for Pipeline construction workers, as computed from changes in total employment and hourly wages, $\epsilon_{LW} = 5.88$ (see Table 3).[33] By this standard, labor supply during the Pipeline era was roughly twice as elastic as during the Gold Rush.

That labor was more elastically supplied during the Pipeline era is not too difficult to rationalize. The Alaska Pipeline was a project of known duration, in which the shock to local labor demand was fully anticipated and the returns to migration more or less certain. By contrast, the discovery of gold was unanticipated, the duration of the Gold Rush was unknown ex ante, and the returns to migration were uncertain. More fundamentally, the vast improvements in internal transportation between 1848 and 1973 dramatically reduced migration costs for the prospective Alaska migrant, compared with costs faced by the prospective argonaut.

5. Conclusion

This paper has examined how the ante-bellum economy coped with a very large, highly localized shock to the demand for labor -- the California Gold Rush. A simple model of wage determination, in which real wages rose sharply during the initial stages of the Rush, and subsequently declined, fit the data reasonably well. However, the Rush was far more than a transitory phenomenon, for it left California wage levels permanently higher. Americans became convinced that the Golden State held riches far beyond the nuggets found at Sutter's Mill. Capital poured into California, sustaining wages after the Rush ended. Newly minted as a state, California left behind its Hispanic economic heritage to become part of the "high-wage" American economy.

6. Appendix

Construction of Nominal Wage Estimates. The nominal wage estimates are constructed in a manner similar to those in Margo and Villaflor (1987). In brief, I multiply the regression coefficients by an assumed set of weights (see Margo (1992) for a more detailed discussion). The seasonal weights are 0.25 each for FALL, WINTER, SPRING; and the HIGH, LOW, and MEXICAN weights are set equal to zero. For common labor-teamsters and artisans, MONTHLY is set to zero; for white collar workers, a monthly wage series is produced (that is, MONTHLY = 1 and I assume 26 days of work per month) because the vast majority of white collar workers were hired on a monthly basis. The fort location and occupation weights are as follows:

Fort	
San Francisco	0.215
Southern CA	0.058
Central CA	0.639
Field	0
Teamster	0.109
Mason	0.056
Blacksmith	0.371
Painter	0.102

The fort weights are averages of population counts in the 1852 state census (DeBow 1853) and 1860 federal census (Kennedy 1864). For the purpose of calculating the fort weights it was necessary to allocate county populations to the forts. The allocation of counties is:

<u>San Francisco</u>: San Francisco, Marin, San Mateo, Alameda, Sulano, Napa, Sonoma.

<u>Southern California</u>: San Luis Obispo, San Bernardino, Santa Barbara, Los Angeles, San Diego

<u>Northern California</u>: Del Norte, Siskiyou, Humboldt, Trinity, Shasta, Mendocino, Colusi, Butte, Plumas

All other counties are allocated to Central California. The occupation weights are averages derived from the 1850 and 1860 federal censuses.

To construct the estimates, multiply each regression coefficient by its relevant weight, sum, and add the coefficient of the appropriate year dummy; call the result, ß. The nominal wage estimate, therefore, is w = exp(ß). As in Margo (1992), I linearly interpolate when the year dummies refer to two or more years grouped together.[34] The nominal wage estimates are:

	Common Labor-Teamsters	Artisans	White Collar
1847	$0.87	na	na
1848	1.21	$4.29	$113.62
1849	2.50	5.72	154.96
1850	3.78	7.16	196.04
1851	3.04	8.01	173.42
1852	2.90	6.30	143.26
1853	2.59	6.08	138.06
1854	2.30	6.00	131.82
1855	2.08	5.83	136.50
1856	2.03	5.99	139.36
1857	2.23	5.02	143.78
1858	2.24	4.77	142.74
1859	2.07	5.03	131.30
1860	2.28	4.58	120.78

<u>Constrcution of Labor Supply Elasticities</u>. This section describes the construction of the labor supply elasticities reported in Table 3. As noted in the text, I identity d(ln L) from estimates of mining employment. To construct these estimates I assume that (a) mining employment in 1847 is zero (b) mining employment in 1850 is as reported in the 1850 federal census, 58,000 (DeBow 1854,

p. 976) (c) mining employment in 1852, 106,000, is estimated by multiplying the total male population in ten mining counties (Butte, Calavares, El Dorado, Sacramento, Mariposa, Nevada, Placer, Sutter, Tuolumene, Yuba) by 0.804, which is the 1850 ratio of total miners in the state to total male population in eight of these counties (Placer and Nevada counties did not exist in 1850) (d) mining employment in 1848 is Caughey (1948, p. 168) estimate (e) mining employment in 1851 is linearly interpolated between 1850 and 1852 (f) mining employment in 1860 is from the federal census (Kennedy 1864, p. 35). To summarize:

	Mining employment
1847	0
1848	5,000
1850	58,000
1851	82,000
1852	106,000
1860	83,000

Next, I use the real wage index for common labor-teamsters to compute d(ln w):

	d(ln w)	d(ln L)	ϵ_{Lw}
1848-50	0.850	2.451	2.88
1848-1851	0.951	2.797	2.94
1848-1852	0.825	3.054	3.70
1848-1850s peak	1.145	3.054	2.67
1848-1860	0.856	2.809	3.28
1850s peak-1860	-0.290	-0.245	0.84

In the case of the "1848-1851" calculation, the real wage is averaged over the three years 1850, 1851 and 1852. In the calculations labelled "1850s peak" the peak real wage (1851) is used. Some caution should be exercised is interpreting the elasticity estimates because of various biases inherent in the estimation procedure.[35]

7. References

Berry, Thomas Senior. 1984. Early California: Gold, Prices, Trade. Richmond, Virginia: The Bostwick Press.

Carrington, William J. 1996. "The Alaskan Labor Market During the Pipeline Era," Journal of Political Economy 104 (February 1996): 186-218.

Caughey, John Walton. 1948. Gold is the Cornerstone. Berkeley, California: University of California Press.

Coman, Katherine. 1912. Economic Beginnings of the Far West. Two Volumes. New York: The MacMillan Company.

Corden, W. Max and J. Peter Neary. 1982. "Booming Sector and De-industrialization in a Small Open Economy." Economic Journal 92 (December): 825-848.

De Bow, J.D.B. 1853. The Seventh Census of the United States, 1850. Washington, DC: Robert Armstrong, Public Printer.

De Bow, J.D.B. 1854. Compendium of the Seventh Census. Washington, DC: Robert Armstrong, Public Printer.

Dixit, Avinash and Robert S Pindyck. 1994. Investment Under Uncertainty. Princeton, New Jersey: Princeton University Press.

Engerman, Stanley and Claudia Goldin. 1991. "Seasonality in Nineteenth Century Labor Markets." National Bureau of Economic Research Working Paper Series on Historical Factors in Long Run Growth, No. 20. Cambridge, MA, January.

Fraser, Robert W. 1983. Forts and Supplies: The Role of the Army in the Economy of the Southwest, 1846-1861. Albuquerque, New Mexico: University of New Mexico Press.

Gerber, James. 1993. "Origins of California's Export Surplus." Agricultural History 67 (Fall): 40-57.

Goodman, David. 1994. Gold Seeking: Victoria and California in the 1850s. Stanford, California: Stanford University Press.

Goldin, Claudia and Robert A. Margo. 1992. "Wages, Prices, and Labor Markets Before the Civil War." In C. Goldin and H. Rockoff, eds. Strategic Factors in Nineteenth Century American Economic History: A Volume to Honor Robert W. Fogel, pp. 67-104. Chicago: University of Chicago Press.

Hamermesh, Daniel. 1993. Labor Demand. Princeton: Princeton University Press.

Kennedy, Joseph C.G. 1862. Preliminary Report on the Eight Census, 1860. Washington, DC: Government Printing Office.

Kennedy, Joseph C.G. 1864. Population of the United States in 1860. Washington, DC: Government Printing Office.

Lavender, David. 1976. California: A Bicentennial History. New York: W. W. Norton.

Lebergott, Stanley. Manpower in Economic Growth: The American Record Since 1800. New York: McGraw-Hill.

Lotchin, Roger W. 1974. San Francisco, 1846-1856: From Hamlet to City. New York: Oxford University Press.

Maddock, Rodney and Ian McLean. 1984. "Supply-Side Shocks: The Case of Australian Gold." Journal of Economic History 44 (December): 1047-1067.

Margo, Robert A. and Georgia C. Villaflor. 1987. "The Growth of Wages in Antebellum America: New Evidence." Journal of Economic History 47 (December): 873-895.

Margo, Robert A. 1992. "Wages and Prices During the Antebellum Period: A Survey and New Evidence." In R. Gallman and J. Wallis, eds. American Economic Growth and Standards of Living Before the Civil War, pp. 173-210. Chicago: University of Chicago Press.

Margo, Robert A. 1997. Antebellum Economic Performance: The Labor Market Perspective, unpublished manuscript, Department of Economics, Vanderbilt University.

Marks, Paula Mitchell. 1994. Precious Dust: The American Gold Rush Era: 1848-1900. New York: William Morrow and Company.

Parke, Charles Ross. 1989. Dreams to Dust: A Diary of the California Gold Rush. Edited by James E. Davis. Lincoln, Nebraska: University of Nebraska Press.

Rosenbloom, Joshua. 1991. "Occupational Differences in Labor Market Integration: The United States in 1890." Journal of Economic History 51 (June): 427-439.

Rosenbloom, Joshua. 1996. "Was There a National Labor Market at the End of the Nineteenth Century? New Evidence on Earnings in Manufacturing." Journal of Economic History 56 (September): 626-656.

Taylor, Alan M. 1996. "Convergence and International Factor Flows in Theory and History." National Bureau of Economic Research Working Paper No. 5798, Cambridge, MA, October.

Umbreck, John. "California Gold Rush: A Study of Emerging Property Rights." Explorations in Economic History 14 (3): 197-226.

Notes

1. The California Gold Rush was not the only gold rush of the nineteenth century, but it was certainly the most famous; see Marks (1994) for a good, general history of nineteenth century gold rushes.

2. The Sutter's Mill discovery was actually not the first in California. Small amounts of gold were found in Southern California near Los Angeles in 1842. Quickly recovered by experienced Mexican miners, a search for additional gold ensued, but none was found (Lavender 1976, p. 3).

3. The share of miners per person in 1850 is biased upwards because of damage to the manuscript census returns from a few non-mining areas, including San Francisco. However, adding in the population counts from the 1852 state census to the denominator would still produce a substantial decline in miners per capita between 1850 and 1860.

4. The 1850 population figure is biased downward because of fire damage to the census manuscripts for San Francisco and other counties.

5. Evidently sending clothes to Hawaii for cleaning (presumably to be picked up on the miner's next trip to San Francisco) could be cheaper than buying a new shirt or trousers, or paying inflated prices for cleaning in San Francisco. Caughey (1848, p. 35) notes that the price of a coarse shirt in 1849 was $16.00, apparently high enough to make the cost of transporting dirty shirts to Hawaii for washing economically feasible.

6. "Dutch Disease" models refer to the effects of supply-side shocks, usually the discovery of natural resources, on other sectors of an economy (for example, manufacturing); see Corden and Neary (1982). The rise in the price of oil in the early 1970s, it is said, caused resources to flow into oil production in countries like the Netherlands, at the expense of manufacturing.

7. By assuming equal endowment shares, I am relegating property rights issues (who owns the gold) to the background (but see footnote 17). For an analysis of property rights issues, see Umbreck (1977).

8. An alternative, essentially equivalent model, divides the population of the gold rush economy into three groups: capitalists (owners of K), workers, and mine owners (owners of ore). The capitalists and mine owners hire labor in a competitive market. Aggregate demands for X and Z are then the sum of the group specific demands (the incomes of the capitalists and mine owners are the rents accruing to K and O). There will be a balanced trade condition similar to the budget constraint in the text.

9. For example, $h = p_x^{ß} p_z^{1-ß}$, where ß is the share of income devoted to X (recall that the price deflators constructed by Goldin and Margo (1992) are of this form).

10. The opposite would be true if demand for labor in the local sector fell, but this cannot happen if X is a normal good.

11. Capital might also be attracted if, in the new equilibrium, L_X is higher than initially.

12. That is, with specialization, there would be a "marginal" worker who, in the initial equilibrium, would be indifferent between gold harvesting and production of the local good.

13. Alternatively, individuals might believe (erroneously) that the gold rush will last "forever", but then be surprised by its end.

14. By convex adjustment costs I mean that, at any time t, the marginal cost of moving L^* units of labor into the gold rush economy is increasing in L^*. Convex adjustment costs are frequently analyzed in dynamic models of labor demand; see, for example, Hamermesh (1993) and Carrington (1996).

15. By "long-run equilibrium value" I mean the value of w in the absence of adjustment costs. With adjustment costs, there is no constant equilibrium value of w for all dates t in the interval (t,t').

16. That is, there is "option value" to waiting if the returns to migration are uncertain; see Dixit and Pindyck (1994). The transport costs of migration are sunk because the good (transportation) is perishable; see, however, Caughey (1948, p. 98) for evidence that some migrants took goods with them to sell in the gold fields, which would be a way of recouping some of the sunk costs.

17. Such a belief would be rational if, as was the case in California, property rights to the gold was not established <u>ex ante</u>. In other words, if property rights had been established, it is plausible that some migration would have been delayed, producing a less elastic labor supply response. I am grateful to Lee Alston for this point.

18. See also Fraser (1983), who argues that the introduction of money by army quartermasters into the local indigenous economies of the Southwest had effects on local prices.

19. The time series are too short to distinguish between the effects of the real shock -- the discovery of gold -- on wages, versus any effects of the increase in the money stock.

20. Comparisons of wages with the 1850 census of social statistics are inadvisable because of the damage to the census manuscripts for San Francisco and other non-mining counties. However, in 1860, the census of social statistics reported an average daily wage of $2.62 for common labor and $4.43 for carpenters, both without board; my estimates are, respectively $2.28 and $4.58 (for artisans). Considering that the census figure is probably an unweighted average of the manuscript figures, the correspondence between the two sources is reasonably good.

21. Hispanic status is inferred from name or from ancillary remarks in the payrolls; as noted by Margo (1992), reporting of names in the payrolls is haphazard, particularly at larger forts.

22. Coman (1912 vol. 2, p. 317) also suggests that nominal wages of carpenters fell before 1853 but, unfortunately, provides no source citations for her wage quotations.

23. To construct the deflator, I used Berry's annual price indices (budget shares in parentheses) for candles (0.098), coffee (0.075), flour (0.150), hams (0.189), raisins (0.033), rice (0.003), cotton sheeting (0.260), sugar (0.085), tobacco (0.025), and butter (0.133). The price deflator is a geometric weighted average of the commodity-specific indices, with weights equalled to the budget shares, as above.

24. The drop in prices in 1848 may reflect the sudden exodus of population from San Francisco for the gold fields. According to Coman (1912 vol. 2, p. 257) real estate prices fell sharply in 1848 in the immediate aftermath of the exodus, and the price deflator suggests that same may have been true of other prices.

25. Berry drew his price quotations from newspapers, and therefore the bulk of the quotations pertain to urban prices (chiefly, San Francisco). Since most goods were transported to the camps from San Francisco (or Sacramento), retail prices at the camps would include transport costs, as well as other mark-ups (Coman 1912 vol. 2, p. 271). However, because of the dependence on urban areas for supply, there is no reason to believe that prices at the mining camps followed a different annual pattern than indicated by Berry's data.

26. Using the state-level figures on the weekly cost of board (from Kennedy 1864, p. 512) and on the daily wages of common labor without board (from Lebergott 1964, p. 541), I compute

$$r = [w_c/b_c]/[w_n/b_n]$$

for 1860, where w is the wage, b is the weekly cost of board, c refers to California, and n refers to the rest of the United States (excluding the West): r = 0.99 (note that r is the same measure of real wages used in Chapter Six). Taken at face value, the calculation suggests that real daily wages in California for common labor on the eve of the Civil War were virtually identical to real wages elsewhere. Similar results were found for male manufacturing workers in 1879 by Rosenbloom (1996, p. 644); not until the late nineteenth and early twentieth centuries did a sizeable real wage gap in favor of the West open up (Rosenbloom, op.cit.).

27. As noted in Section 1, East Coast ships did occasionally trade manufactured goods for furs in pre-Gold Rush California, but their small numbers and infrequent stops make it difficult to maintain in any reasonable sense that pre-Gold Rush California was integrated into the American economy (see Coman 1912 vol. 1, p. 165).

28. For example, if r is computed for the Northeast in 1860 as in footnote 23 (that is, the real wage of common labor in California relative to the real wage of common labor in the Northeast), projecting back using the real wage series for California common labor in this chapter and for Northeastern common labor in Chapter Three, real wages of common labor in California were 26 percent higher than in the Northeast in 1851.

29. 1850 and 1860 estimates in current dollars of capital in manufacturing and of population are from DeBow (1853) and Kennedy (1862). Nominal capital per person is deflated by Berry's overall price index (1984, p. 235, column 1). Improved acres and wheat output are from Kennedy (1862, pp. 196, 200). For further discussion of the emergence of California agriculture during the Gold Rush period, see Gerber (1993).

30. Nominal wage estimates derived from the non-Southern California regression are higher in level than those derived from the regressions in Table 2. For example, the nominal wage estimate for 1850 for common labor is $4.96, very close to Coman's (1912 vol. 2, p. 269) estimate for "Coast towns".

31. The elasticity of labor supply appears to have been somewhat smaller in the case of the Australian Gold Rush. According to Maddock and McLean (1984, p. 1065), real wages in Victoria increased by 85 percent between 1850 and 1852. Maddock and McLean do not report labor quantities, but using population or net migration (see Maddock and McLean 1984, p. 1048) as a substitute yields elasticities of 1.3 (population) to 1.7 (net migration).

32. My estimates of the labor supply elasticity into Gold Rush California are somewhat larger than Rosenbloom's (1991, p. 435) estimate (ϵ_{Lw} = 1.96) for common labor in the building trades in the late nineteenth century. Rosenbloom's

estimate is derived in a very different manner from those in Table 3; in particular, it is the coefficient of the real wage in a log-linear cross-sectional regression of city level data on hourly wages and employment. Although it is difficult to known exactly what the proper interpretation of Rosenbloom's elasticity is, one reasonable interpretation that it reflects the responsiveness of labor supply to persistent differences in real wages across cities.

33. The assumption that daily hours of work in Gold Rush California did not increase biases the elasticity downward, compared with the Alaska figure. However, daily hours of work in Gold Rush California would have had to increase to roughly twenty hours per day to equal the Alaska figure. In addition, if the non-Southern California real wage series is used (see Figure 9), the elasticity estimates would be lower. Thus, it seems likely that even allowing for a (daily) intensive margin, the California elasticity is less than the Alaska elasticity.

34. Also, as in Margo and Villaflor (1987), all nominal wage estimates for 1849 are linearally interpolated.

35. For example, the 1850 federal census estimate of mining employment may be understated because of damage to certain census manuscripts, although this appears to have been confined to San Francisco and two non-mining counties.

Table 1

Distribution of Wage Observations:
California Forts, 1847-1860

	Unskilled	Artisan	White Collar
By year:			
1847-50	0.186	0.104	0.098
1851-55	0.665	0.616	0.657
1856-60	0.149	0.280	0.245
By occupation:			
Laborers	0.397		
Teamsters	0.603		
Masons		0.135	
Painters		0.022	
Blacksmiths		0.242	
Carpenters		0.601	
By location:			
San Francisco	0.151	0.199	0.498
Northern CA	0.065	0.131	0.094
Central CA	0.183	0.121	0.133
Southern CA	0.588	0.545	0.270
"Field"	0.013	0.004	0.005
N	3,731	1,254	610

Source: sample of California forts from Reports of Persons and Articles Hired; see text.

Table 2

Hedonic Wage Regressions: California Forts

	Common Labor-Teamster	Artisan	White Collar
Constant	0.857	1.408	1.037
	(7.082)	(10.141)	(4.043)
Monthly	0.005	-0.281	0.437
	(0.152)	(10.745)	(2.586)
High	na	0.333	0.304
		(5.732)	(5.060)
Low	-0.702	-0.242	-0.431
	(7.100)	(0.819)	(4.516)
Mexican	-0.810	na	na
	(8.267)		
Spring	0.095	-0.010	-0.009
	(2.670)	(0.198)	(0.094)
Summer	-0.246	0.147	0.044
	(5.648)	(2.676)	(0.417)
Fall	-0.065	0.123	-0.063
	(1.818)	(2.853)	(0.637)
Teamster	0.119		
	(6.892)		
Mason		-0.045	
		(1.373)	
Painter		-0.207	
		(2.805)	
Blacksmith		-0.155	
		(5.919)	
San Francisco	0.059	0.068	0.129
	(1.497)	(1.536)	(1.930)
Central CA	0.020	0.168	0.071
	(0.483)	(3.424)	(0.837)
Southern CA	-0.269	0.126	-0.074
	(7.855)	(3.161)	(1.043)
"Field"	-0.320	-0.667	-0.203
	(4.036)	(3.847)	(0.749)
1847	-0.960	na	na
	(6.221)		
1847-48			-0.509
			(2.388)
1848	-0.633	-0.065	
	(4.842)	(0.393)	
1850	0.504	0.447	0.485
	(4.660)	(3.207)	(2.463)
1851	0.286	0.560	0.362
	(2.623)	(3.995)	(1.684)
1852	0.238	0.319	0.170
	(2.188)	(2.253)	(0.900)
1853	0.126	0.283	0.133
	(1.170)	(2.041)	(0.717)

Table 2 (continued)

1854	0.009	0.270	0.087
	(0.083)	(1.976)	(0.474)
1855	-0.093	0.242	0.123
	(0.862)	(1.792)	(0.674)
1856	-0.116	0.268	0.144
	(1.064)	(1.974)	(0.786)
1857	-0.023	0.092	0.174
	(0.198)	(0.613)	(0.822)
1858	-0.018	0.042	na
	(0.142)	(0.284)	
1858-59			0.160
			(0.764)
1859	-0.099	0.095	na
	(0.721)	(0.583)	
R^2	0.593	0.425	0.455

Source: see Table 1. Left out seasonal dummy is "Winter"; left out location dummy is "Northern CA"; left out occupation dummies are laborers (common labor-teamster regression) and carpenters (artisan regression); left out year dummy is "1860".

Table 3

The Elasticity of Labor Supply

	ϵ_{Lw}
California	
1848-50	2.88
1848-51	2.94
1848-52	3.70
1848-1850s peak	2.67
1848-60	3.28
1850s peak-1860	0.84
Alaska Pipeline (1973:3-1976:6)	
Aggregate, monthly earnings versus employment	1.01
Construction, monthly earnings versus employment	2.04
Construction, hourly earnings versus employment	5.88
Construction, hourly earnings versus total hours	6.67

$\epsilon_{Lw} = d(\ln L)/d(\ln w)$

Source: California, see Appendix; Alaska Pipeline: computed from data in Carrington (1996, pp. 198, 206, 208).

Figure 1

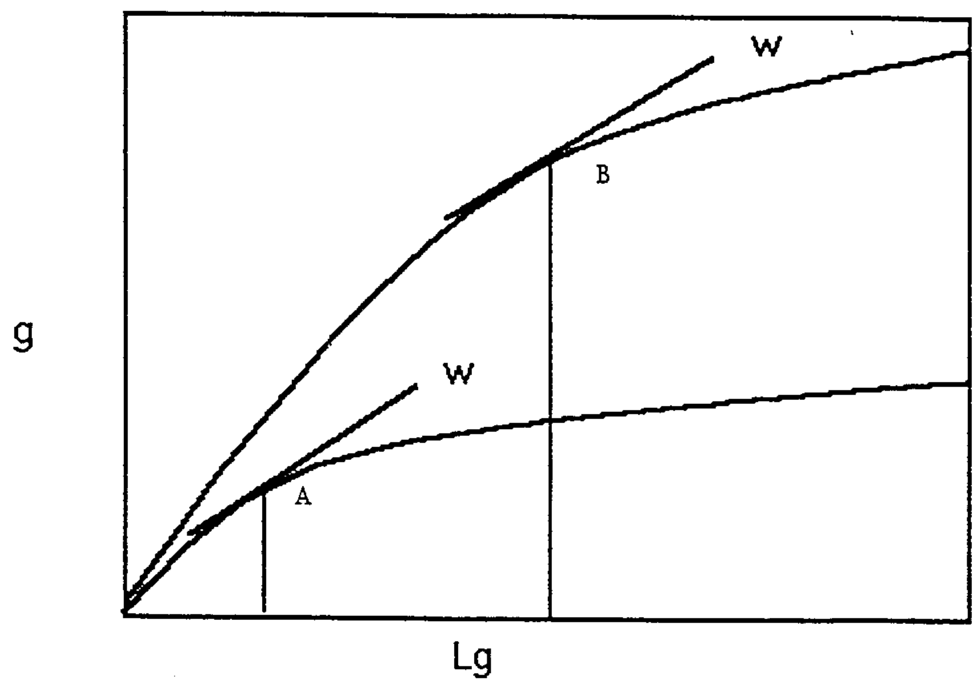

Figure 2

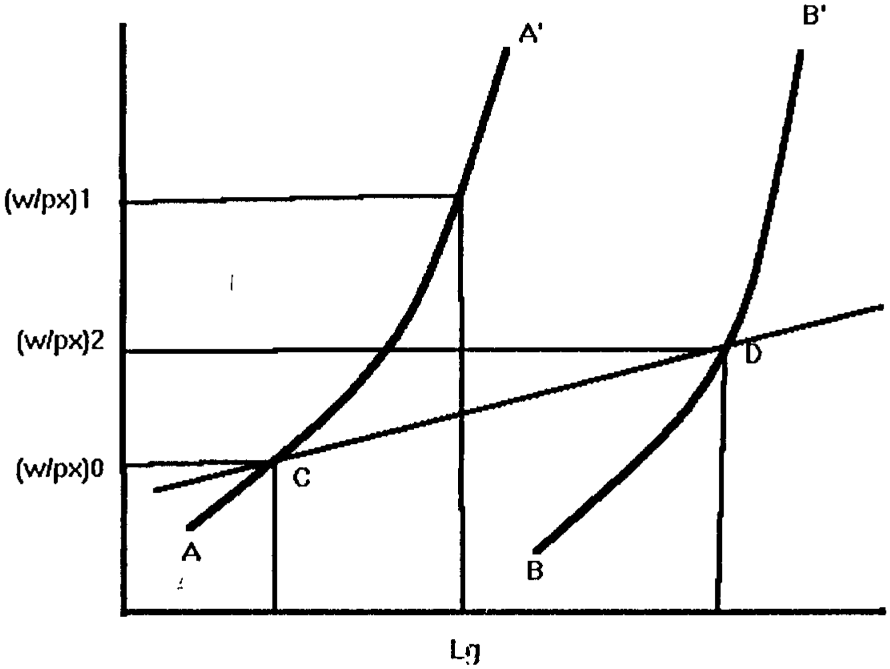

Figure 3

Wage Dynamics: Convex Adjustment Costs

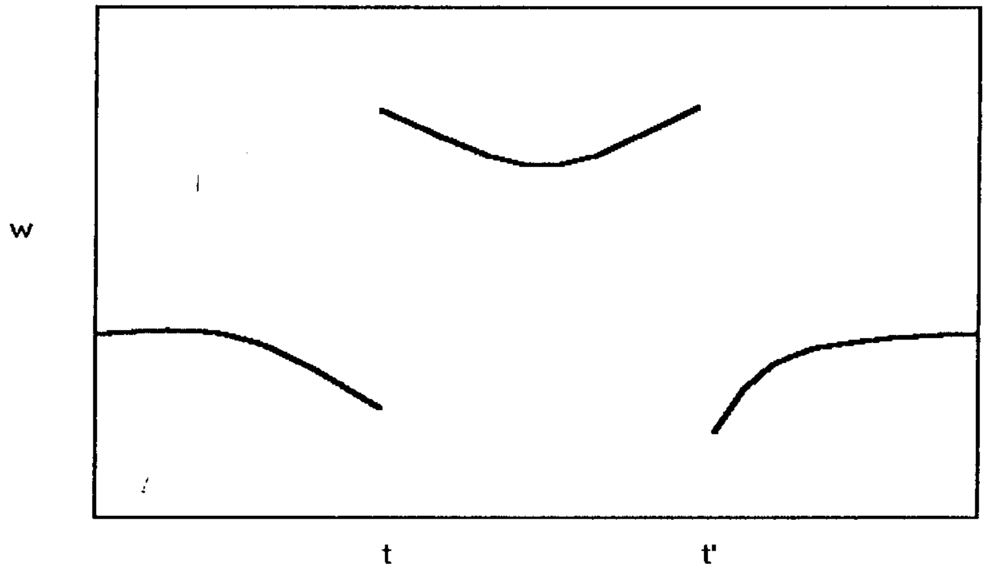

Figure 4

Wage Dynamics: Zero Adjustment Costs