

ESSAYS ON FINANCIAL LIBERALIZATION, LABOR MARKET POOLING,
AND INTERMETROPOLITAN WAGE DIFFERENTIALS

by

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SUBMITTED TO THE DEPARTMENT OF ECONOMICS IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY IN ECONOMICS
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SEPTEMBER 1997

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Doctor of Philosophy in Economics.

ABSTRACT

Chapter 1 analyzes the effects of financial liberalization on asset prices in the context of an OLG model in which consumers borrow to buy houses. Liberalization takes two forms: removal of internal restrictions on consumer borrowing and removal of external capital controls. Consistent with the experiences of many countries after liberalization, the model generates (under a range of circumstances) a boom and bust in the price of houses following liberalization. External liberalization proves neither necessary for the result, nor particularly interesting in the context of the model.

Chapter 2 examines evidence for one variant of the labor market pooling hypothesis, which has been advanced as one motive for economic agglomeration. A popular version of the hypothesis holds that workers value locations where demand shocks among firms are relatively less correlated, since such markets reduce the risk of unemployment and the variance of the wage. Evidence for worker valuation of pooled markets is presented in the context of two models, one which generates a cross-city real wage prediction, and one which generates a cross-industry wage prediction within any given city. Available data provide some support for the first model. Evidence for the second model is much weaker.

Chapter 3 examines the proposition that firms value access to large markets. Modern geography theories imply that proximity to local markets is valuable to firms because it reduces the share of production subject to transport costs. As such, workers in remote markets should be less valuable to firms and receive lower wages. Evidence for this proposition is examined under the assumptions that U.S. economic activity centers around three regional hubs--New York, Los Angeles, and Chicago. The results indicate that nominal wages in a city fall with distance from the nearest hub. In manufacturing, the magnitude of the effect is approximately 1 percentage point for every 100 miles.

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ACKNOWLEDGMENTS

One name appears as author of this dissertation, but in truth there should be two. My wife, Dina, deserves at least equal mention for her part in this enterprise. Her love, patience, and simple faith made the difficult periods bearable, and the tranquil ones delightful. I shall endeavor to merit her love and confidence in the years ahead.

My advisors, Rudi Dornbusch and Olivier Blanchard, deserve some sort of commendation for their commitment to a trying student. They have been extraordinarily generous with their time, attention, and friendship. My intellectual debt to them is enormous, but far more important is the personal one. I have had the rare opportunity to become acquainted with Rudi's singular, provocative, and completely charming approach to life and economics. I shall greatly miss our Boston excursions, which provided a setting for discussions about my work, the economics profession, and the pleasures of collecting art. Olivier has provided a model of professionalism and integrity that I would do well to emulate. The frustrations one encounters in trying to meet Olivier's high standards are tempered by his genuine interest in the success and well-being of his students, as well as his wry humor. In addition to having Olivier as an advisor, I have been fortunate to serve as his teaching assistant, perhaps my most important learning experience at MIT.

All students in international economics at MIT are grateful for the addition of Jaume Ventura to the Department. Jaume has acted as an unofficial third advisor, at times a cheerleader, and always a supporter. For a time we were in the habit of weekly chats over lunch or breakfast. These discussions were immensely useful in structuring my research, and great fun. I shall miss Jaume's good fellowship and cheerful enthusiasm for economics. Daron Acemoglu

offered important comments on Chapter 1, and was always available for an off-the-cuff chat about my work. I should have taken better advantage of the opportunity. Bill Wheaton provided data that were useful to Chapters 2 and 3, and offered advice. Beyond those faculty members directly involved with my dissertation, I am grateful to many others for the high quality of their teaching and their commitment to students. I also learned much from Michael Kremer as his teaching assistant.

I was fortunate to begin my graduate studies in the company of an exceptional class of students, whose intellectual curiosity and energy added much to my experience at MIT. Rather than mention them all, let me single out David Riker as study partner, friend, and fellow traveler in international economics. Dave and I visited MIT on the same day in 1992, and now find ourselves starting our careers less than 100 miles apart in California. I look forward to many years of collegiality and friendship ahead.

I would be remiss not to mention Ernie Berndt, for whom I served as research assistant for three years. It was Ernie's misfortune that my dissertation research had little connection with his work, and I fear that Ernie's productivity suffered in the competition for research time. Ernie showed remarkable patience and generosity, however, and placed my work ahead of his. He never complained, openly accepted me as a colleague and friend, and offered support at every turn. In some ways I have learned more from Ernie than anyone else at MIT. I hope we will have the opportunity to work together in the future.

I would also like to acknowledge financial support from the National Science Foundation and the MIT World Economy Laboratory, and comments on Chapter 1 from seminar participants at the University of California, Irvine; the University of Illinois; Brandeis University;

Washington University at St. Louis; the Federal Reserve Board of Governors; and the Federal Reserve Bank of Kansas City.

Finally, and not for the last time, I would like to thank my parents for a lifetime of sacrifice, love, and commitment to my education and success. My mother's love of words ensured that books would always be honored in our house, and my father's work in the labor movement stimulated my interest in politics and economics. I lost my father in the course of my stay at MIT. I miss him. It is to his memory that I dedicate this dissertation.

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INTRODUCTION

This dissertation contains three essays, in two parts. The first part (Chapter 1) examines the behavior of economies after financial markets are deregulated. The second part (Chapters 2 and 3) explores explanations for wage differentials across U.S. cities and motives for economic agglomeration. Although each essay could fit comfortably into macroeconomics proper, I was motivated initially in each case by open-economy questions, particularly factor mobility. As such, I consider this dissertation to fall under the rubric of open-economy macroeconomics.

Financial liberalization has become a salient feature of economic reform efforts worldwide. It is thus surprising that there has been relatively little formal analysis of the effects of liberalization policies. In Chapter 1, I build a framework to analyze financial liberalization, particularly as it affects asset prices. The framework encompasses both internal liberalization, which means (in the context of the model) elimination of restrictions on consumer credit, and external liberalization, which refers to elimination of capital controls. I am motivated by the experiences of many countries in the aftermath of liberalization, during which asset prices often follow a boom and bust cycle. Although economic post mortems on the episodes often point to specific reasons for specific cases, I am interested in whether there is something in the nature of liberalization that tends to produce this asset price cycle.

I build a model in which consumers borrow to buy houses and show that under a range of circumstances liberalization can generate boom and bust dynamics in the price of houses. These dynamics are fully anticipated, once liberalization occurs. The asset price cycle occurs in the absence of external shocks, which are cited as an explanation for specific post-liberalization experiences. Moreover, in the context of my model, external liberalization is neither necessary

to produce an asset price cycle, nor particularly interesting. This stands in contrast to typical discussions of financial liberalization episodes which emphasize capital inflows. Although in fact capital inflows are associated with liberalization experiences, and undoubtedly opening the capital account has broader effects than simply access to the world interest rate (the effect I consider), my results suggest that there is something structural about liberalization that tends to produce the asset price cycle.

Chapters 2 and 3 are motivated by the new economic geography literature. Chapter 2 examines the evidence for a labor market pooling explanation for economic agglomeration. One variant of the labor market pooling story holds that risk-averse workers value markets in which shocks to employers are less correlated, thereby reducing the likelihood of unemployment and the variance of wages. If workers value such markets, they will accept lower wages in them, which makes such markets attractive to firms as well. Although such worker preferences are not necessary for pooling to explain agglomeration, since firms could value pooled markets for other reasons, the worker risk aversion story is a typical element of the labor market pooling explanation for agglomeration.

I test the proposition that workers value pooled markets in Chapter 2, in the context of two models. In the first, workers choose locations before they receive jobs; in the second, workers receive job offers before they choose a location. The first model generates a cross-city test of labor market pooling based on the local employment rate and the variance of the real wage, which I relate to the variance of the employment rate through assumptions. The second model generates a cross-industry prediction about wages within any given city based on the covariances of employment shocks among local industries. To evaluate these models, I use wage

data from the Current Population Survey and employment data from USA Counties and County Business Patterns. I aggregate the employment data into cities. The first model fits the data reasonably well with respect to the variance of the employment rate, but not the mean. The results indicate that an increase of one (cross-sectional) standard deviation in the variance of the employment rate would be associated with a 7 percentage point increase in the relative cross-city real wage. On the other hand, increases in the mean employment rate would also be associated with increases in the relative real wage, a result at odds with the compensating differential framework. The labor market pooling hypothesis does not generate a clear prediction about the relationship between the mean and the variance of the employment rate, however, so this result remains a puzzle in the context of Chapter 2. Evidence for the second model is much weaker. In the context of examining this evidence, it became clear that local employment share was a strong and positive predictor of within-city wage differentials. Potential explanations for this intriguing result fall outside the scope of the pooling model, but suggest avenues for further research.

Chapter 3 continues the exploration into economic geography by examining the proposition that firms value access to large markets. It is a common implication of modern models of economic geography that proximity to local markets is valuable to firms because it reduces the share of production subject to transport costs. As such, workers in remote markets should be less valuable to firms and thereby receive lower nominal wages. To create an empirical framework to explore this proposition, I assume that U.S. economic activity centers around three regional hubs--New York, Los Angeles, and Chicago--and use the distance to these hubs as a measure of market access. The results indicate that wages in a city fall with distance

from the nearest hub, even after controlling for local market size. In manufacturing, the magnitude of the effect implies that an increase of 100 miles from the nearest hub is associated with a 1 percentage point fall in nominal wages. Real wages, by contrast, apparently rise with distance. The results are consistent with the economic geography models, although not conclusive, and suggest that distance has a role in explaining U.S. metropolitan wage differentials.

CHAPTER 1: FINANCIAL LIBERALIZATION AND THE ASSET PRICE CYCLE

1. INTRODUCTION

Financial liberalization has become a central element of policy reform for developing economies. Yet despite growing international experience with financial liberalization policies, there is relatively little formal analysis of their macroeconomic effects. In this paper, I analyze the effects of liberalization on asset prices. In particular, I investigate whether liberalization can produce boom-bust dynamics, *i.e.*, asset price cycles. I also explore the role of capital inflows in generating such dynamics.

My motivation is fourfold. First, financial liberalization has been followed by booms and busts in asset prices in a number of cases over the past two decades. In Finland, for example, liberalization in the first half of the 1980s was followed by a 90% increase in real housing wealth between 1986 and 1989. Housing wealth fell by 50% over the next two years. After financial deregulation in Uruguay, housing prices rose more than 180% in dollar terms between 1978 and 1980, only to fall by about as much by 1982. Chile, Argentina, Australia, and New Zealand, among others, also experienced booms and busts in asset prices after deregulation.¹

¹See Diaz-Alejandro (1985), Bisat, Johnston and Sundararajan (1992), Dornbusch and Park (1995), Fischer and Reisen (1993), Sundararajan and Balino (1991), and Velasco (1991) for well-informed discussions of international experiences with financial liberalization. Kaminsky and Reinhart (1996) examine episodes of banking and balance of payments crises, and argue that financial liberalization helps predict banking crises, and banking problems help predict balance of payments problems. The countries cited in the text had booms and busts in the stock market as well as the real estate market, although the asset price swing in Australia was largely a commercial real estate phenomenon. Since my framework focuses on collateralizable consumer assets--houses--I provide the real estate statistics in the text. The figures on Finland are derived from Soderstrom (1993); the figures on Uruguay are cited in Rebelo and Vegh (1995).

Second, financial liberalization has often occurred in tandem with other policy reforms and in the presence of macroeconomic shocks. Hence, it is difficult to isolate the effects of financial liberalization in specific cases.

Third, liquidity constraints figure prominently in attempts to explain the consumption booms that are often observed after financial liberalization and exchange rate stabilization policies.² The argument is that these policies remove limits on consumer borrowing, either directly through deregulation or indirectly through remonetization. As a result, consumers borrow heavily to purchase durables. Some argue that the policy reforms generate "over"-borrowing, which ultimately creates a drag on the economy.

Finally, international economists are preoccupied with capital inflows, particularly as they relate to financial liberalization. Swings in asset prices are often attributed to fluctuations in capital flows.

With these four observations in mind, I build a framework to analyze the effects of financial deregulation in isolation, apart from other policy experiments or macroeconomic shocks. To formalize the story about liquidity constraints and consumption, I limit attention to deregulation of consumer credit markets and focus on houses as assets. To explore the role of capital inflows, I consider both regulation of domestic credit markets and capital controls that prevent borrowing and lending with the world economy.

I show that financial deregulation can generate a rise and fall in the price of houses. Moreover, I show that capital inflows are not necessary to produce this asset price cycle. In

²See, for example, Copelman (1994).

fact, in the model explored in this paper, elimination of capital controls dampens the asset cycle. Prices immediately after liberalization are higher when only domestic regulations are eliminated, and capital controls maintained, than when domestic regulations and capital controls are lifted simultaneously. Before describing the formal model, I shall provide some intuition for these results.

Think about a world in which consumers desire to purchase one house in life, but face borrowing restrictions, say high downpayment requirements. Imagine that houses have some minimum size, so consumers cannot avoid binding downpayments by incremental consumption of houses. Consumers who wish to buy houses will have to accumulate savings to satisfy the initial downpayment requirement. At any point in time, there will be a set of consumers who have accumulated varying levels of assets in preparation for making a downpayment. Imagine that there is a smooth flow through time of consumers who have accumulated any given level of assets; in particular, a smooth flow of consumers who have accumulated sufficient assets to purchase a house. The consumers who have accumulated less than the required downpayment represent a latent demand for housing that has been repressed by the downpayment requirement.

Now suppose the downpayment requirements are reduced (or eliminated) unexpectedly. Immediately after the reduction of borrowing restrictions, there will be an increase in demand for houses, relative to the usual flow of consumers who are able to afford a house, because a smaller stock of assets is required for purchase. Once this initial increase in demand has been satisfied, demand for houses will return to its usual flow through time. As a result of these changes in demand, it is natural to think that the price of houses might rise initially, then fall.

Prices will not always follow this cycle after elimination of borrowing restrictions, however, because the downpayment requirements also affect real interest rates. The fact that consumers save for downpayments tends to reduce the real interest rate below its equilibrium level in the absence of downpayment requirements. This effect can be quantitatively large (on interest rates and prices) because of a feedback effect. When the price of houses increases in the face of downpayment requirements, consumers may save more to meet their higher downpayment. As a result, real interest rates will tend to fall, and the price of houses will tend to increase further, starting the cycle again. The increase in real interest rates which tends to accompany financial liberalization may cause prices to fall.

Formally, I use an overlapping generations framework in which consumers borrow to purchase houses. Financial regulation takes the form of limitations on borrowing through government-imposed downpayment requirements and capital controls which prevent domestic residents from borrowing or lending on world capital markets. The forced savings created by regulation are captured by the transfer of wealth across generations. In an unregulated economy, consumers who own houses in the old period of life borrow against them to finance consumption of other goods, and leave no financial wealth to future generations. In a regulated economy, consumers who own houses are prevented from borrowing fully against their assets, and thus are forced to transfer wealth to future generations. I assume that such wealth bequests are distributed equally among members of the incoming young generation. Thus, all

consumers enter life with financial wealth in a regulated economy, but without wealth in an unregulated one.³

Although the intergenerational wealth transfer in the regulated economy arises from the savings of those who own houses, it captures the idea that borrowing restrictions may encourage savings by potential buyers of houses, since members of the young generation who buy houses have these assets available. Once liberalization occurs, those who own houses in the old period of life borrow fully against them, leaving no wealth for future generations. In other words, the repressed demand for houses is exhausted. As a result, future generations enter life without assets, consumers reduce their demand for houses, and the price falls. This is the bust phase of the asset price cycle. Whether the price rises initially after liberalization depends on the strength of interest rate effects, as described earlier.

The model, though stylized, illustrates that credit restrictions can create interesting dynamics for asset prices. In this respect, it fits into the growing body of research on the effects of credit markets and collateral on economic fluctuations, including, among others, Bernanke and Gertler (1989), Shleifer and Vishny (1992), Kiyotaki and Moore (1995), and Holmstrom and Tirole (1994). Unlike these papers, however, I model credit constraints on consumption, rather than on investment. Moreover, my results do not rely on the interaction of information or contracting problems and the state of the economy, but rather on the response of consumers to elimination of restrictions in an economy in which there are no

³I assume no bequest motive in the model. If I were to include a bequest motive, there would be a transfer of wealth to future generations in all cases. In this sort of model, to make deregulation interesting, I would have to assume that the initial regulation was binding, *i.e.*, forced a greater transfer of wealth than consumers would otherwise desire.

underlying information problems. The steady state of the model is closest in spirit to Stein (1995), who introduces the notion that downpayment requirements may have important effects on housing prices.⁴

The next section of the paper sets out the basic framework for analysis and compares the steady states of regulated and unregulated economies. I analyze the regulated economy in the special case where downpayment requirements are 100%. I term this case the fully-regulated economy. In addition, for purposes of exposition, I allow consumers to purchase houses only in the first period of life. Under this assumption (and ignoring a price bubble), steady states are unique equilibria. Price paths after liberalization are also uniquely determined.

Section 3 starts from the steady state of the fully regulated economy described in Section 2, and analyzes the dynamics of asset prices after a policy of eliminating domestic borrowing restrictions, while maintaining capital controls. I call this policy domestic liberalization. Section 4 starts from the same initial position as Section 3 and considers dynamics after a simultaneous elimination of domestic regulations and international capital controls. I call this policy international liberalization. Section 5 examines some extensions of the model and discusses the results. Section 6 concludes. An Appendix explores the implications of relaxing the assumption that consumers can buy houses only in the first period of life. In this case, the economy will move to a steady state after liberalization only under

⁴Engelhardt (1996) provides evidence that downpayment requirements for house purchases act as binding liquidity constraints in the U.S.

some restrictions on parameter values. When these restrictions are imposed, the price dynamics after liberalization are similar to those described in the text.

2. STEADY STATES IN THE UNREGULATED AND FULLY-REGULATED ECONOMIES

In this section, I describe an overlapping generations framework for analysis of financial liberalization and compare steady states in regulated and unregulated economies. I consider an extreme form of regulation which eliminates all consumer borrowing. I term this case the fully-regulated economy.

Under an assumption I impose in this section, and ignoring a bubble solution for prices in the unregulated economy, steady-states are unique equilibria. For clarity, I begin by solving for steady states. Later, in Section 2.8, I prove that these steady states are the only equilibria. These proofs will also be useful in the analysis of deregulation. I will highlight in this section the assumption that ensures uniqueness, and consider in the Appendix the implications of relaxing this assumption.

Comparing steady states, I show that the real interest rate is lower in the fully-regulated economy than in the unregulated one. The comparison of prices depends upon the strength of the real interest rate effect in the unregulated economy and feedback effect between prices and interest rates in the regulated economy. If these effects are small, the price of houses is larger in the unregulated economy. Otherwise, the price is larger in the regulated one.

2.1 THE BASIC FRAMEWORK FOR AN UNREGULATED ECONOMY

Consider an economy populated by consumers who live two periods, in overlapping generations. One generation dies each period and one is born. Each generation consists of a continuum of agents of measure 1. Thus, in each period, two generations--a young and an old--are active, and the total population has measure 2.

The economy has two goods--a nondurable consumption good and a durable consumption good, which I shall call a house. Consumption of houses can occur only in discrete units of size one. For ease of exposition, I assume that consumers may purchase nondurables in either period of life, but may purchase houses only when young. This assumption is not necessary to generate an asset price cycle, but it ensures that steady states are unique equilibria for fully-regulated and unregulated economies (ignoring price bubbles in the latter case). The assumption will also ensure a unique price path after financial liberalization.

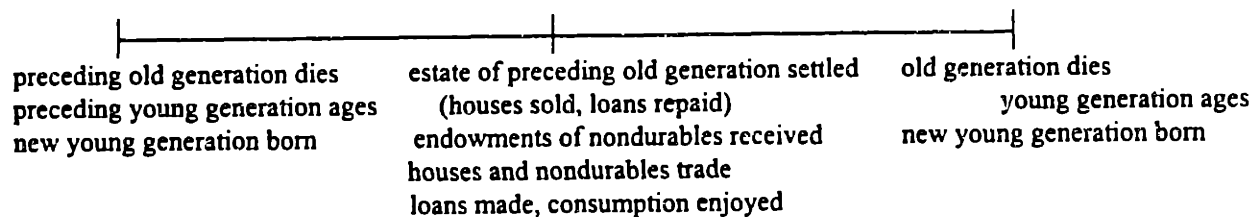
In each period of life, each consumer is endowed with one unit of the nondurable good. In addition, the economy in aggregate is endowed with a measure $2m$ of houses. I assume $0 < m < 1$. In each period, a measure m of each incoming young generation will purchase a house and keep it for both periods of life.⁵ The upper bound on m , coupled with the indivisibility of housing consumption, implies that some members of the young generation will purchase houses and some will not. Those who buy houses will become borrowers in the young generation and those who do not buy houses will become lenders. Thus, consumers divide naturally into borrowers and lenders as a result of the choices they face, and not because of intrinsic differences

⁵If $m < 1/2$, there is another equilibrium in which successive young generations alternately buy all the houses and buy no houses. In order to rule out this possibility, assume that the initial two generations are each endowed with a measure m houses.

in taste or wealth. Since I will construct the model to ensure that members of the young generation have identical wealth, they must be indifferent between housing choices. This indifference drives the price of houses.

In the second period of life, those who own houses desire to use them as collateral for borrowing to finance consumption of other goods. Since I assume there is no bequest motive, owners in the second period of life will desire to borrow as much as possible. In the unregulated economy, the only limit on this borrowing is that the future value of the house be sufficient to repay the loan, with interest. As a result, in the unregulated economy, homeowners in the old generation borrow until the net worth of their estates is zero. After they die, their houses are sold and the proceeds used to settle outstanding debts.

To fix ideas, I set out below the timing of events in each period:



Finally, I assume that capital controls prevent borrowing and lending on the world capital market. When I analyze international deregulation, *i.e.*, simultaneous elimination of capital controls and domestic borrowing restrictions, I shall assume that the world rate of interest equals the autarky rate for an unregulated economy. As a result, there will be no international borrowing in the steady state of an unregulated economy.

2.2 THE CONSUMER'S PROBLEM IN THE UNREGULATED ECONOMY

Consumers, who are identical, have lifetime utility defined as follows:

$$U = \ln(c_y) + \beta \ln(c_o) + (1 + \beta)f(h) \quad (1)$$

where c refers to consumption of nondurables, h to the number of houses consumed, and subscripts to the period of life--“y” (young) or “o” (old). I assume that once one unit of housing has been purchased, additional units have no value for the consumer, so no one will purchase more than one unit of housing at positive prices.⁶ In particular, I assume that $f(h)=0$ if $h=0$ and $f(h)=\ln(\theta)$ if $h \geq 1$, where $\theta > 1$.

I will assume that β , the consumer’s weight on future utility, equals one. In other words, future utility is not discounted. This assumption is not necessary for my qualitative results, but simplifies the exposition algebraically, and makes for more transparent analysis of the effects of other parameters.⁷

Homeowners in the old period of life will desire to use their houses as collateral to finance consumption of nondurables. This borrowing will be limited only by the fact that the future price of the house must be sufficient to repay the loan with interest. In other words, in steady state, total borrowing for an old homeowner may not exceed $P/(1+r)$, where P is the price of houses.

⁶No one will purchase more than one house as long as the price of houses is not expected to rise faster than the real rate of interest. Since there is no uncertainty in the model, a growth rate of prices greater than the real interest rate would present a pure arbitrage opportunity, and everyone would borrow to buy houses. Equilibrium rules out such a price path. This point is not relevant in steady state, but does figure in the proof that steady states are unique equilibria. See Section 2.8.

⁷The assumption about the discount rate has no effect on the price of houses as a function of the interest rate in the unregulated economy, but does affect the interest rate. Since a zero discount rate minimizes the value of the unregulated real interest rate (as a function of the discount rate), this assumption maximizes the unregulated price of houses. It also maximizes the regulated price, however. Essentially, the assumption has no qualitative significance. Moreover, in general, there is a lower bound on β below which the equilibrium real interest rate becomes imaginary in an unregulated economy. Choosing $\beta=1$ avoids this issue entirely.

Given the framework outlined above, the consumer's budget constraint, expressed as the limit on consumption of nondurables when old, is the sum of three components: (1) the endowment of one unit of the nondurable good, (2) total credit obtained against the value of houses owned, and (3) the payment of principal and interest on net lending from the young period of life. Equation (2) expresses the budget constraint in terms of these three components:

$$c_o = 1 + \frac{hP}{1+r} + (1 - c_y - hP)(1+r) \quad (2)$$

where P is the relative price of houses in terms of the nondurable good, h is the number of houses purchased, and r is the real interest rate. Recall that $h \in (0,1)$ by construction. Since I focus on steady states in this section, I ignore time subscripts on P and r in equation (2).

The consumer's problem is to choose h and c_y . The housing choice is discrete. Given either housing choice, however, the consumer will optimize utility (1) over consumption of the nondurable good, subject to the budget constraint (2). This program yields the familiar first-order condition:

$$c_o = (1+r)c_y \quad (3)$$

where it will be recalled that $\beta=1$. The first-order condition and the budget constraint together imply a consumption path (equation (4)), which depends on the housing choice.

$$c_y = \frac{2+r}{2(1+r)} - \frac{r(2+r)}{2(1+r)^2} hP = \left(\frac{c_o}{1+r} \right) \quad (4)$$

The choice facing the consumer is clear--the purchase of a house comes at the expense of some consumption of the nondurable good. Those who choose not to purchase a house ($h=0$) will lend in the first period of life. Those who do purchase a house ($h=1$) will borrow in both

periods of life. In the second period, the ability to borrow will be limited by the value of the house as collateral.

2.3 STEADY STATE IN THE UNREGULATED ECONOMY

An equilibrium steady-state in the unregulated economy is defined by three conditions:

(1) constant P and r over time, (2) market clearing in houses and nondurables, and (3) indifference between purchasing and not purchasing a house for members of the young generation.

A measure m members of each young generation will purchase houses and a measure $(1-m)$ will not. This is the market clearing condition for houses. I will use a prime superscript to signify buyers of houses in each generation. Market clearing in nondurables requires:

$$m[c'_y + c'_o] + (1-m)[c_y + c_o] = 2 \quad (5)$$

where it will be recalled that each generation receives an aggregate endowment of 1 in each period, so the economy's endowment is 2.

Indifference between purchasing and not purchasing a house for members of the young generation requires that lifetime utility be the same for either decision. In other words:

$$\ln(c'_y) + \ln(c'_o) + 2\ln(\theta) = \ln(c_y) + \ln(c_o) \quad (6)$$

Exponentiating the indifference relation in (6) and substituting the first-order condition (3),

$$(1+r)c_y'^2 \theta^2 = (1+r)c_y^2$$

$$\theta c'_y = c_y \quad (7)$$

Given the first-order condition, equation (7) also holds when old-period consumption is substituted for young-period consumption. Substituting (7) into the market clearing condition,

$$\left[\frac{m+\theta(1-m)}{\theta}\right][c_y+c_o]=2$$

Substituting the first-order condition and defining $x=[m+\theta(1-m)]/\theta$, then substituting young-period consumption of nondurables for nonbuyers ($h=0$ from (4)),

$$x(2+r)c_y=2$$

$$x\frac{(2+r)^2}{2(1+r)}=2 \quad (8)$$

The parameter x will reappear in the analysis. Note that $m<1$ and $\theta>1$ imply that $x<1$, and that x is decreasing in both parameters.

Equation (8) is a quadratic in r . Solving for the positive root,

$$r=2\left(\frac{1-x+\sqrt{1-x}}{x}\right) \quad (9)$$

A negative real interest rate would imply that everyone would want to borrow, which cannot be an equilibrium, so the positive root is appropriate.

Finally, substituting young-period consumption for buyers and nonbuyers (from (4)) into the simplified indifference relation in (7) and rearranging gives the price of houses:

$$P=\left(\frac{1+r}{r}\right)\left(\frac{\theta-1}{\theta}\right) \quad (10)$$

P and r functions of the parameters m and θ . Equation (9) implies that r falls with x .

Since x is a decreasing function of m and θ , r is an increasing function of both parameters. Since

increases in the interest rate reduce the price of houses by (10), P falls when m rises. One can also show from (10) that $dP/d\theta > 0$, so that the price rises with θ .

The intuition for these relationships is straightforward. An increase in the utility value of houses (θ) makes houses more desirable and increases their price. A higher price of houses increases borrowing by those who buy houses, so the interest rate rises to induce more lending from nonbuyers in the young generation. Likewise, an increase in the stock of houses ($2m$) increases demand for credit, since all homeowners desire to borrow, and causes the real interest rate to increase. The rise in the real interest rate improves lifetime utility for those who do not purchase houses, since they are lenders. As such everyone would opt not to purchase houses if the price of houses did not fall. The intertemporal considerations combine with the indifference requirement between housing options to produce the ordinary result that prices fall when supply increases.

2.4 THE BASIC FRAMEWORK FOR THE FULLY-REGULATED ECONOMY

The regulated economy differs from the unregulated economy in that the government limits the amount of debt that consumers may accumulate. In particular, consumers may owe no more than $(1-\gamma)$ worth of total assets in either period of life. Consumers who purchase houses own a house and a claim to a future endowment of one unit of the nondurable. Hence, these consumers have total assets of $P+1/(1+r)$. The regulated value γ effectively creates a minimum downpayment requirement, $\bar{\gamma}$, where $\bar{\gamma}P$, the minimum initial outlay for a house, is given by

$$\bar{\gamma}P \equiv P - (1-\gamma)\left(P + \frac{1}{1+r}\right) \quad (11)$$

I assume that γ is high enough to bind, in both periods, on those who buy houses. In addition, I continue to assume that international borrowing and lending is prohibited for domestic residents.

Although financial regulation takes many forms other than downpayment requirements, I choose to model regulation in this way for two reasons. First, some countries have imposed direct limitations on consumer mortgage borrowing. Finland, for example, imposed a mandatory downpayment requirement for first-time homebuyers prior to its financial liberalization. Second, I want to argue more generally that an important effect of many forms of financial regulation has been to limit the ability of consumers to smooth consumption of nondurable goods when purchasing houses or other durable goods. Downpayment requirements provide a direct and simple way to model this idea.

In addition to limiting the ability of homebuyers to smooth consumption of nondurable goods, the borrowing restriction also implies that homeowners will die with positive net worth. According to the timeline in Section 2.1, when the estates of the preceding (and deceased) old generation settle (houses sold and loans repaid), there will be financial assets available to distribute to the new young generation.

I assume that any remaining assets from the estates of the preceding old generation are distributed equally to the members of the new young generation. Since there is no bequest motive, this assumption is reasonable within the framework I have described. For my purposes, the assumption of equal distribution of assets eliminates individual (or dynastic) wealth dynamics from the analysis.

For ease of exposition, I will consider the special case where $\gamma \rightarrow 1$, so that borrowing is effectively prohibited. This extreme case, which I term the fully-regulated economy, has a closed-form solution and illustrates clearly the basic results of the model.

2.5 THE CONSUMER'S PROBLEM IN THE FULLY-REGULATED ECONOMY

By definition, there will be no borrowing or lending in the fully-regulated economy. As a result, each homeowner in the old generation of life will transfer an entire house to the next young generation. Given equal distribution of assets to the young and a stock m of houses held by each generation, members of each young generation will have mP in initial assets.

Consumers who purchase houses when young will have a nondurable consumption path of $c'_y = 1 - (1 - m)P$ and $c'_o = 1$. Consumers who choose not to purchase houses when young will make an optimal decision, since, nominally, they are not restricted. Their problem differs from the corresponding problem in the unregulated economy in only one respect--they now have mP in initial assets. The first-order condition for their nondurable consumption path will be the same as before, namely $c_o = (1 + r)c_y$. The real interest rate will adjust so that the nondurable consumption path involves no lending on the part of those who do not purchase houses.

2.6 STEADY STATE IN THE FULLY REGULATED ECONOMY

The steady state of the fully regulated economy follows immediately from the consumption path of homebuyers. Market clearing requires that nonbuyers have a nondurable consumption path of $c_y = 1 + mP$ and $c_o = 1$. The real interest rate will adjust so that nonbuyers satisfy the first order condition, so that:

$$r = \frac{1}{1+mP} - 1 \quad (12)$$

Equation (11) implies that r will be negative in the steady state of the fully-regulated economy.

The restrictions on borrowers reduce real interest rates.

The other condition that defines equilibrium is indifference between purchasing and not purchasing a house for members of the young generation. This indifference condition was described in equation (6). Substituting the consumption paths (associated with buying and not buying houses) into the indifference condition (6) gives the steady-state solution for the house price:

$$P = \frac{\theta^2 - 1}{m + \theta^2(1 - m)} \quad (13)$$

The relationship between variables and parameters differs from the unregulated case. P is an increasing function of θ , but unlike the unregulated case, an increasing function of m as well. In addition, in contrast to the unregulated economy, the real interest rate is a decreasing function of both parameters. The intuition for the differences in the effects of parameters on P and r has to do with a feedback effect between prices and interest rates in a regulated economy. This will be described in the next section, when equilibrium prices in the two economies are compared.

2.7 UNREGULATED VERSUS FULLY-REGULATED ECONOMIES

I have shown that the steady-state real interest rate in the fully-regulated economy is lower than in the unregulated economy. The remaining question concerns the price of houses.

Using the expressions for the steady-state housing prices in (10) and (13), the price in the unregulated economy exceeds the price in the regulated economy if and only if:

$$r = \frac{2(1-x+\sqrt{1-x})}{x} < \frac{m+\theta^2(1-m)}{\theta(m\theta+1)-m} \quad (14)$$

where r refers to the interest rate in the unregulated economy. Recall that $x = [m+\theta(1-m)]/\theta$.

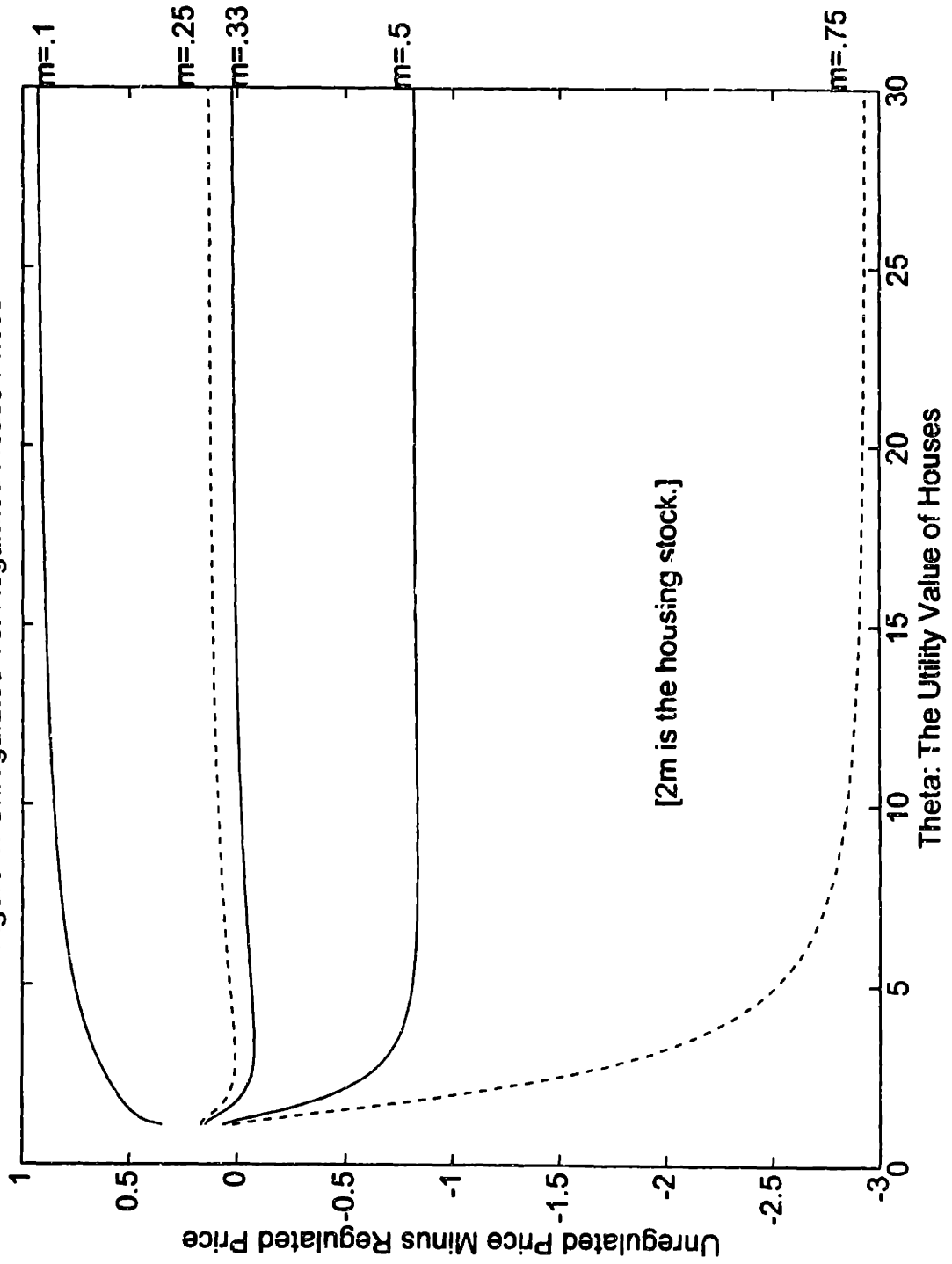
This condition makes intuitive sense, since the unregulated price is a decreasing function of the interest rate.

Condition (14) holds when m is small enough (close enough to 0) or θ is small enough (close enough to 1). As $\theta \rightarrow \infty$, the condition will hold unless m is sufficiently large (close enough to 1). The condition will fail if $m=1$ and θ is sufficiently large. For intermediate values of m , the condition holds for θ outside an intermediate range (small enough or large enough). Figure 1 plots the difference between unregulated and fully-regulated prices for various parameter values.

At first glance, it may seem strange that prices could be higher in a regulated economy. The result arises from a feedback effect between prices and saving. One can interpret the intergenerational wealth transfer as the savings of potential buyers of houses, since these assets are available to young buyers of houses. If a housing market is characterized by downpayment requirements and some discreteness in housing sizes, increases in the price of houses may encourage more saving from potential buyers, since they must accumulate a downpayment. At any given price, increases in saving decrease the real interest rate, which increases the price of houses, which increases saving, and so on.⁸ The feedback effects do not exist in the unregulated

⁸Note that decreases in the real interest rate make the credit restrictions more binding, since lower rates increase the desire of consumers to tilt consumption toward the present.

Figure 1: Unregulated Vs. Regulated House Prices



economy, where there are no borrowing restrictions. If underlying parameters are such that the price of houses would tend to be large, and the feedback effect is strong enough, then the price can be higher in the regulated economy.

Within the model, the parameter that most directly affects the price of houses is θ , the utility value of houses. Although increases in θ tend to increase the price in both regulated and unregulated economies, such increases reduce the real interest rate in the regulated economy (through the feedback effect) but increase the rate in the unregulated economy (through a straightforward credit demand effect). The parameter m does double duty. In the regulated economy, m indexes the feedback effect of prices on saving, since total savings available to young buyers is mP . In the unregulated economy, m acts as a supply effect; increases in the stock of houses reduce the price.

When m or θ are small, real interest rates are low in the unregulated economy, which tends to increase the price, and feedback effects are low in the fully-regulated economy, which tends to reduce the price. As a result, prices tend to be higher in the unregulated economy. As the parameters increase in value, interest rates get higher in the unregulated economy and feedback effects get stronger in the regulated one, so the difference in prices narrows and is perhaps eliminated. As θ gets large, the price tends to get high in either economy. At high prices, consumption smoothing becomes very important (as $\theta \rightarrow \infty$, young-period consumption goes to zero for buyers in the regulated economy). This effect tends to increase the gap between prices in the unregulated and regulated economies. Finally, for m close to one, the feedback effect is very strong in the regulated economy, but interest rates are high in the unregulated one, so the price tends to be higher in the regulated economy.

2.8 STEADY STATES AS UNIQUE EQUILIBRIA

Ignoring potential price bubbles, the steady states for the fully-regulated and unregulated economies represent the unique equilibria of these economies. This is readily apparent for the fully-regulated economy, since in the absence of borrowing, the decision problems reduce to one period. For the unregulated economy, I prove below that a steady state in real interest rates is the unique equilibrium. For prices, there are two equilibria--a steady state or a price bubble (uniquely-determined, conditional on an initial value), in which prices grow at the rate of interest in the limit. These propositions will prove useful in the analysis of deregulation.

PROPOSITION 1: A constant real interest rate is the unique equilibrium in the unregulated economy.

Proof: Define r_t to be the real interest rate earned on a one-period loan maturing at time $t+1$. Then, consumption of nondurables for young, nonbuyers at time t is given by $c_{y,t} = (2+r_t)/(2(1+r_t))$, and consumption of old, nonbuyers by $c_{o,t+1} = (1+r_t)c_{y,t}$. The simplified form of the indifference condition in (7) still applies at each point in time when r is allowed to vary through time. Adding the appropriate time subscripts to the market clearing condition for nondurables in (2) gives:

$$m[c'_{y,t} + c'_{o,t}] + (1-m)[c_{y,t} + c_{o,t}] = 2 \quad (15)$$

This condition can be reexpressed in terms of nonbuyer's consumption by substituting (7) and rearranging, and then in terms of real interest rates by substituting the consumption of nonbuyers:

$$x[c_{y,t} + c_{o,t}] = 2$$

$$x \left[\frac{2+r_t}{2(1+r_t)} + \frac{2+r_{t-1}}{2} \right] = 2 \quad (16)$$

One solution for (16) is $r_{t,t} = r_t = r^*$, where r^* is the steady-state value determined in Section 2.3.

Equation (16) implies that $r_{t,t} > (<) r^* \Rightarrow r_t > (<) r^*$. Rearranging (16),

$$r_t = \frac{4(1-x) - r_{t-1}x}{3x - 4 + r_{t-1}x} \quad (17)$$

Taking the derivative with respect to r_{t-1} :

$$\frac{dr_t}{dr_{t-1}} = \frac{1}{\left(3 - \frac{4}{x} + r_{t-1}\right)^2} \quad (18)$$

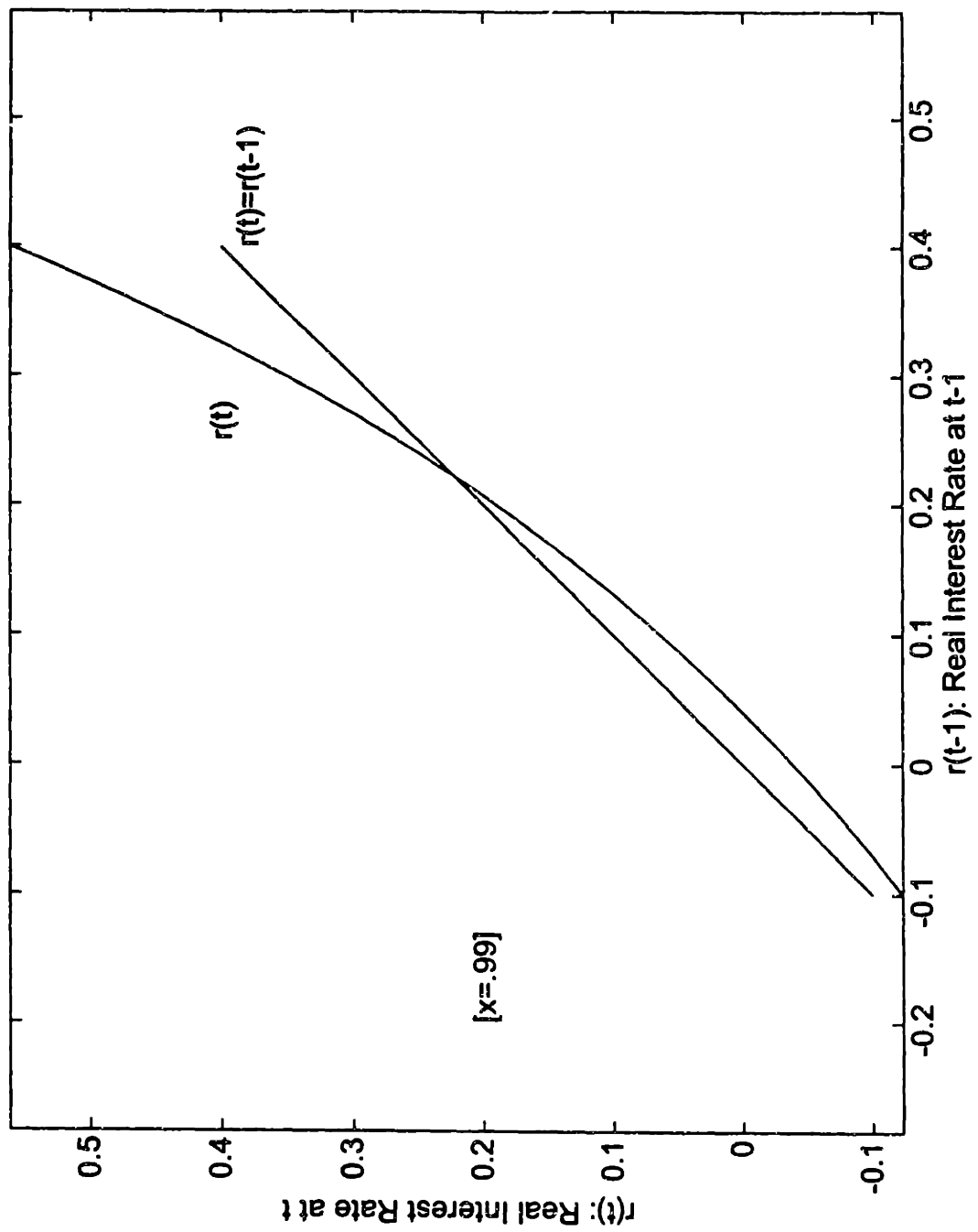
The real interest rate at time t is a positive function of its lagged value.

Equilibrium in the unregulated economy requires the real interest rate to be positive.

Otherwise, everyone will want to borrow. $r_t > 0 \Rightarrow 4(1-x)/x < r_{t-1} < (4-3x)/x$. (Note that the steady-state value r^* , defined in (9), lies within this range for all values of x .) For this range of r_{t-1} , the derivative in (18) is increasing, since $x < 1$. At the lower bound for r_{t-1} , the slope is one; as r_{t-1} approaches its upper bound, the slope becomes infinite.

Figure 2 illustrates the graph of r_t as a function of r_{t-1} for $x = .99$ (chosen for graphical convenience). At the lower bound for r_{t-1} , $r_t = 0$, so this point is below the 45° line. For any initial value of r less than r^* , the real interest rate will grow smaller. Since the slope in (18) is greater than one for permissible values of r_{t-1} , eventually r_t will fall below the lower bound on

Figure 2: Convergence of r in the Unregulated Economy



r_{t-1} , and r_{t+1} will become negative, which cannot be an equilibrium. Likewise, any initial value of the real interest rate greater than r^* implies that r_t will ultimately exceed the upper bound on r_{t-1} , which means that r_{t+1} will be negative, which cannot be an equilibrium. So, for any r_0 that initializes a possible equilibrium path, the only equilibrium is $r_t=r^*$ for all t . \blacktriangle

PROPOSITION 2: For a constant real rate of interest, the unregulated economy is characterized by either a constant equilibrium price or a bubble solution, with prices rising in the limit at the rate of interest. Conditional on an initial price, the bubble path is unique.

Proof: For a constant real interest rate, young period consumption of nondurables for buyers of houses can be written as follows:

$$c'_{y,t} = \frac{2+r}{2(1+r)} + \frac{P_{t+2}}{2(1+r)^2} - \frac{P_t}{2} \quad (19)$$

The second term in (19) reflects the fact that borrowing against the house in the old period of life will be limited by the future value of the house when old, *i.e.*, the *future* value of the house at time $t+1$.

Young period consumption for those who do not buy houses is given by the first term on the RHS of (19). Substituting these consumption values into the simplified indifference condition (7) and rearranging gives:

$$P_{t+2} = P_t(1+r)^2 - \frac{(\theta-1)(1+r)(2+r)}{\theta} \equiv P_t(1+r)^2 - K \quad (20)$$

where K , the negative of the second term in the middle expression, is a positive constant. Ignoring the RHS definition for the moment, and subtracting P_t from each side of the first equality,

$$P_{t+2} - P_t = r(2+r)(P_t - P^*) \quad (21)$$

where $P^* = (\theta - 1)(1+r)/(\theta r)$, the steady-state value for an unregulated economy. Clearly P_{2t} will rise forever at increasing increments if P_0 is greater than P^* , and will fall forever at increasing increments if P_0 is less than P^* .

Suppose $P_0 < P^*$. Since P_{2t} falls forever at increasing increments, P_{2t} becomes negative in finite time. This cannot be an equilibrium path.

Suppose $P_0 > P^*$. So P_{2t} rises forever at increasing increments. Since (20) describes a relationship between prices every two periods, consider even ($2t$) and odd ($2t-1$) periods, initialized by P_0 . Note that arbitrage rules out any price path such that $P_t(1+r) < P_{t+1}$. This implies that prices must be rising in odd periods as well as even periods, *i.e.*, that $P_t > P^*$. Taking the limit of (20) as $t \rightarrow \infty$,

$$\lim_{t \rightarrow \infty} \frac{P_{2t+2}}{P_{2t}} = (1+r)^2 - \lim_{t \rightarrow \infty} \frac{(\theta - 1)(1+r)(2+r)}{\theta P_{2t}} = (1+r)^2 \quad (22)$$

where the second equality in (22) follows from the fact that P_{2t} rises forever at increasing increments. (22) also holds in odd time periods. Equation (22), together with the no arbitrage condition, implies that the limiting price ratio in successive time periods is $1+r$.

Consider first the limiting price ratio between even and odd periods. Using the definition in (20),

$$\frac{P_{2t}}{P_{2t-1}} = \frac{P_0(1+r)^{2t} - K \sum_{j=0}^{t-1} (1+r)^{2j}}{P_1(1+r)^{2(t-1)} - K \sum_{j=0}^{t-2} (1+r)^{2j}} = \frac{P^0(1+r)^2 - K - K \sum_{j=1}^{t-2} (1+r)^{-2j}}{P_1 - K \sum_{j=1}^{t-2} (1+r)^{-2j}} \quad (23)$$

where P_0 and P_1 are prices in the two initial periods. Imposing the limiting condition and rearranging,

$$\lim_{t \rightarrow \infty} \frac{P_{2t}}{P_{2t-1}} = 1+r \quad \Leftrightarrow \quad P_1 = P_0(1+r) - \frac{K}{(2+r)} \quad (24)$$

Note that $P_0 > P^*$ implies that $P_1 > P_0$ in the RHS expression in (24). Now consider the price ratio between odd and even periods.

$$\frac{P_{2t+1}}{P_{2t}} = \frac{P_1(1+r)^{2t} - K \sum_{j=0}^{t-1} (1+r)^{2j}}{P_0(1+r)^{2t} - K \sum_{j=0}^{t-1} (1+r)^{2j}} = \frac{P^1 - K \sum_{j=1}^t (1+r)^{-2j}}{P_0 - K \sum_{j=1}^t (1+r)^{-2j}} \quad (25)$$

From (25),

$$\lim_{t \rightarrow \infty} \frac{P_{2t+1}}{P_{2t}} = 1+r \quad \Leftrightarrow \quad P_1 = P_0(1+r) - \frac{K}{(2+r)} \quad (26)$$

so there is a price path which will satisfy a limiting growth rate of r between all periods, and, given a $P_0 > P^*$, this price path is unique. It is straightforward to show that the RHS condition in (26) implies $P_t < (1+r)P_{t-1}$ for all t .

So, if $P^* < P_0$, there is only one equilibrium price path, conditional on P_0 . Along this path, prices will grow forever, reaching a limiting growth rate of the rate of interest.

Thus, the only equilibrium for constant r is $P_t = P^*$ for all t or a bubble path of prices. \blacktriangle

3. THE ASSET PRICE CYCLE I: DOMESTIC LIBERALIZATION

Having described the steady states in two polar economies--unregulated and fully-regulated--I now turn to the transition from one to the other. In this section I consider the effects of removal of domestic restrictions on consumer borrowing, while maintaining international capital controls. I call this policy domestic liberalization. It turns out this deregulatory policy is equivalent to a policy of first removing domestic restrictions, then lifting capital controls. In the next section, I analyze a policy of simultaneously removing domestic credit restrictions and international capital controls. This policy I call international liberalization. I ignore potential price bubbles in the analysis.

Asset dynamics after domestic liberalization will last two periods. In the second period after liberalization, the price and interest rate move to their steady-state level for an unregulated economy. In the transitional period, the real interest rate rises above its fully-regulated level, but remains below its steady-state level. Depending upon interest rates, the price of houses may rise or fall during the transition. The price definitely falls after the transition, however. Thus, two price paths are possible after liberalization; either the price first rises, then falls--a price cycle--or the price falls for two periods to its steady-state value.

3.1 LONG-RUN EQUILIBRIUM AFTER LIBERALIZATION

Suppose deregulation occurs at the end of period t . At time $t+1$, young consumers will enter life with initial assets left by the last old generation of house buyers under regulation. After this time, there will be no intergenerational transfer of wealth, since those who own houses in the old generation will borrow as much as possible against the value of their houses.

By time $t+3$, no one in the young or old generation will have lived under regulation or received a wealth transfer. Thus, the economy will look exactly like the unregulated economy described in Section 2.8, where prices and interest rates were allowed to vary over time. In particular, the relationship between r_{t+3} and r_{t+2} will be exactly as described in Section 2.8. Thus, from Proposition 1, the only equilibrium is $r_{t+3}=r_{t+2}=r^*$, the steady-state real interest rate for an unregulated economy. The real interest rate will thus be constant beginning at time $t+2$. By Proposition 2 (again ignoring price bubbles) the price must be constant at its steady-state value, as well.

So the price and real interest rate move to their steady-state values for an unregulated economy two periods after domestic liberalization. By the assumption that the world rate of interest is the autarky rate for an unregulated economy, the economy moves to the world rate of interest two periods after liberalization. As a result, domestic liberalization is equivalent to a policy of removing domestic borrowing restrictions at the end of period t , then removing international capital controls at the end of period $t+1$.

3.2 THE TRANSITIONAL PERIOD AFTER DOMESTIC LIBERALIZATION

The budget constraints for buyers and nonbuyers of houses in the young generation are given by:

$$c'_o = 1 + \frac{P^*}{1+r^*} + (1+r)(1-c'_y - (1-m)P) \quad (27)$$

$$c_o = 1 + (1+r)(1-c_y + mP)$$

where r and P refer to variables in the transitional period, and an asterisk indicates steady-state values. Both budget constraints reflect the mP in initial assets transferred by the preceding old generation. In addition, the second term on the RHS of the budget constraint for buyers reflects the fact that future borrowing against the value of the house will be limited by the *future* present value of the house, which will depend on the steady-state price and interest rate.

Buyers and nonbuyers will each maximize utility (1) as before, subject to the appropriate budget constraint in (27). The first-order condition will remain unchanged. The solutions for young-period consumption are:

$$c'_y = \frac{2+r}{2(1+r)} - \frac{(1-m)P}{2} + \frac{P^*}{2(1+r)(1+r^*)} \quad (28)$$

$$c_y = \frac{2+r}{2(+r)} + \frac{mP}{2}$$

Members of the old generation in the transitional period made saving decisions in a fully-regulated economy. Those who did not buy houses saved nothing, and consume their endowment of one unit of the nondurable good. Those who did buy houses were forced to save the entire value of their houses, since borrowing was effectively prohibited. Buyers have the opportunity to borrow against their houses in the transitional period after liberalization. As a result, consumption for old-generation buyers is $1+P^*/(1+r)$. Note that the ability of these buyers to borrow against their houses in the transitional period depends upon the future price, but the current interest rate.

Writing the market clearing for nondurables, substituting appropriate consumption levels and the solution for P^* (from (10)), and rearranging gives the solution for r :

$$\begin{aligned}
& mc'_o + (1-m)c_o + mc'_y + (1-m)c_y = 2 \\
m\left(1 + \frac{P^*}{1+r}\right) + (1-m)(1) + m\left[\frac{2+r}{2(1+r)} - \frac{(1-m)P}{2} + \frac{P^*}{2(1+r)(1+r^*)}\right] + (1-m)\left[\frac{2+r}{2(1+r)} + \frac{mP}{2}\right] = 2 \\
& r = \frac{(1-x)(3+2r^*)}{r^*} \tag{29}
\end{aligned}$$

In addition to market clearing in nondurables, the other condition that determines equilibrium is indifference between purchasing and not purchasing a house for members of the young generation. The simplified form of the indifference condition (*i.e.*, $\theta c'_y = c_y$) derived earlier for the unregulated economy still applies. Substituting the consumption levels from (28) and solving for the price,

$$P = \frac{P^*}{x} \left[\frac{1+2r^*+rr^*}{1+r^*+r+rr^*} \right] \tag{30}$$

Equations (29) and (30) characterize the equilibrium for the transitional period after domestic deregulation. Ignoring price bubbles, they represent the unique solution to market clearing in nondurables and indifference between housing choices in the transitional period. One constraint that has not been discussed is market clearing in nondurables in the second period after deregulation. It is clear that market clearing is satisfied in every period after the second, since the economy is identical to the unregulated one. In the second period after deregulation, the steady-state price and interest rate impose equilibrium in the loan market, since members of the young generation make the same decisions they would in the unregulated steady state, and old generation buyers borrow the same amount ($P^*/(1+r^*)$) as they would in the unregulated steady-state. Loan market equilibrium guarantees equilibrium in the market for nondurables. After substituting appropriate consumption levels into the second period market-clearing condition,

one can verify that this condition reduces to the solution for the real interest rate in (29). So, second-period market clearing has been imposed.

3.3 THE ASSET PRICE CYCLE

The transitional interest rate given in (29) is positive and thus greater than the rate in the fully-regulated economy. Using (29) and the expression for r^* in (9) to substitute for $(r^*)^2$,

$$r^* - r = \frac{(1-x)}{xr^*} [2r^*(2-x) + 4 - 3x] \quad (31)$$

The RHS of (31) is positive (recall that $x < 1$), so the transitional interest rate is less than the steady-state rate. After domestic deregulation, the real interest rises for two periods, then remains constant. The intuition for this result is that consumption by members of the old generation in the transitional period is limited by the fact that they could not save during the young period of life because the economy was regulated. As a result, members of the young generation must consume an amount greater than steady-state consumption by the young. Such an equilibrium is established by a real interest rate below its steady-state value.

Given that $r < r^*$ and $x < 1$, (30) implies that $P > P^*$, the transitional price is greater than the steady-state price. This is the bust phase of the asset price cycle. This arises because the intergenerational transfer of wealth ceases after liberalization. In the transitional period, young consumers receive initial assets from the estates of the last old generation under regulation. In the second period after liberalization, young consumers do not receive initial assets because members of the preceding old generation who owned houses borrowed fully against them. The

elimination of the intergenerational wealth transfer represents the resolution of the repressed demand for houses created by regulation.

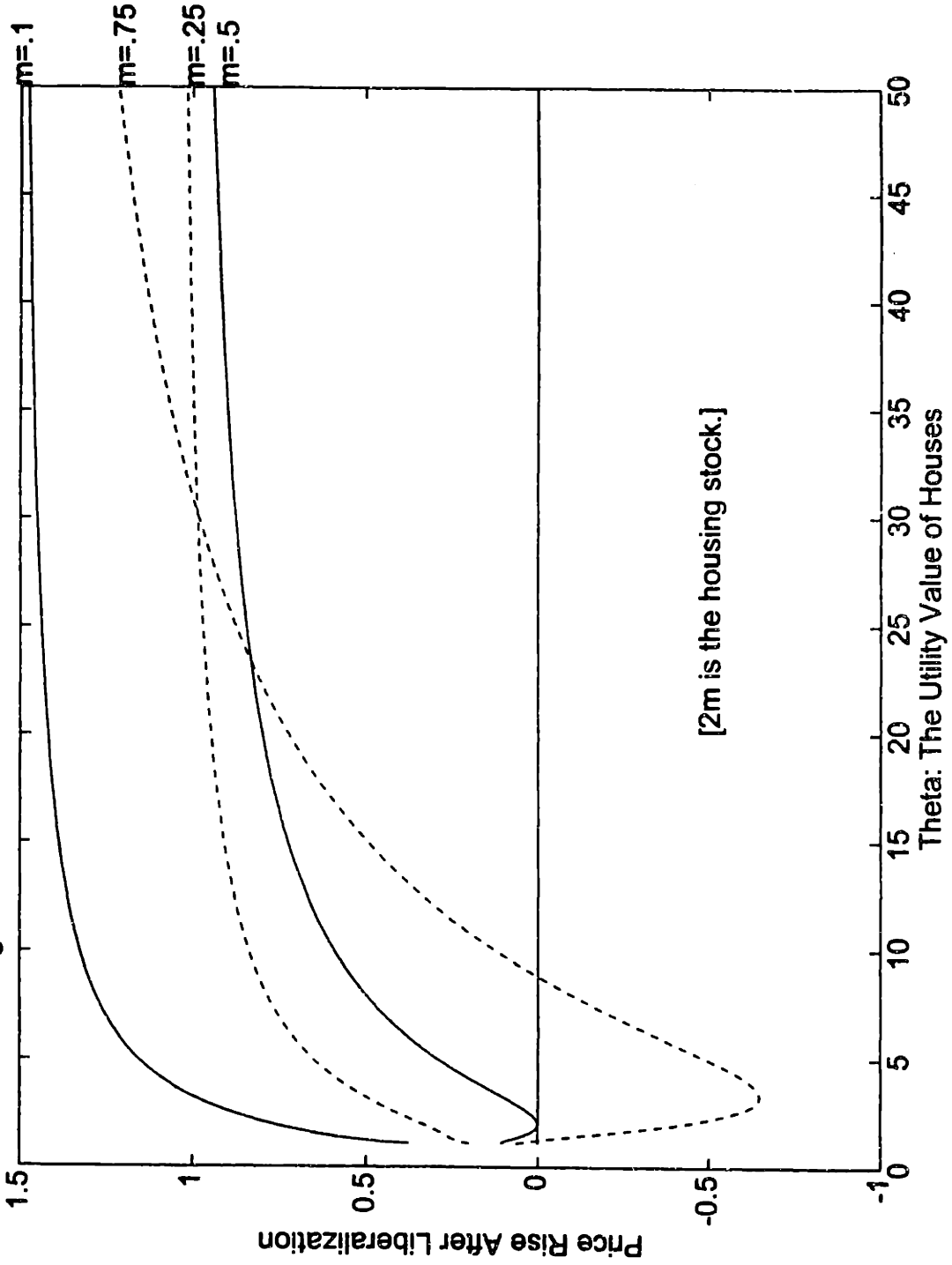
Whether there is an initial boom in the price of houses depends on parameters. Comparing the transitional price to the fully-regulated price in (13), substituting for the transitional interest rate, and rearranging, the condition that prices rise in the transitional period is equivalent to

$$\frac{2r^*(2-x)+4-3x}{r^*(3-2x)+3(1-x)} > \frac{\theta(1+\theta)}{m+\theta^2(1-m)} \quad (32)$$

The condition in (32) will be satisfied if $m \rightarrow 0$ or $\theta \rightarrow 1$. In either case, $x \rightarrow 1$ and $r^* \rightarrow 0$. If $\theta \rightarrow \infty$, the condition will be satisfied as long as m is not too large (sufficiently less than one). If $m \rightarrow 1$, the condition will fail if θ is sufficiently large. For intermediate cases, given m , the condition is first less likely, then more likely to be satisfied as θ rises from one. As such, given m , there is an intermediate range of θ within which the condition fails. Otherwise, it holds. Figure 3 plots the difference between the transitional price and the fully-regulated price over various parameter values.

The intuition for the price results is similar to the intuition for the gap between steady-state prices in unregulated and regulated economies. The parameters affect the tradeoff between interest rate effects and the benefits of free credit markets for the unregulated economy, and the strength of feedback effects in the regulated one. For low values of m or θ , the real interest rate is low in the unregulated economy, tending to increase the transitional price, and the feedback effect on price in the regulated economy is low, tending to reduce the regulated price. So a boom is likely.

Figure 3: The Price Boom After Domestic Liberalization



As the parameters increase, real interest rates increase in the unregulated economy and feedback effects increase in the regulated one, narrowing and perhaps eliminating the gap. So a boom is less likely. As θ gets very large, however, then price tends to get large in both the unregulated and regulated economies. As such, consumption smoothing becomes more important, which tends to increase the difference between the transitional price and the price in the fully-regulated economy. When m is close to one, however, feedback effects are very strong in the regulated economy, so the regulated price may be higher than the transitional one if the underlying value of houses-- θ --is large enough.

Putting together the results on prices, there are two possible price paths after domestic deregulation (again ignoring price bubbles). Either the price rises in the first period and falls in the second (the asset price cycle), or prices fall for two periods. The price is constant beginning in the second period.

4. THE ASSET PRICE CYCLE II: INTERNATIONAL LIBERALIZATION

In this section, I consider the effects of a simultaneous removal of domestic borrowing restrictions and capital controls, a policy I call international liberalization. Given the results in Section 3, the only difference between this policy and domestic liberalization is that the economy will face the world rate of interest in the first period. I assume that the world interest rate is the autarky rate for an unregulated economy, *i.e.*, the steady-state rate, r^* . Given this assumption, the economy moves to its steady-state value of r and P in the second period after international liberalization.

Since the transitional rate after domestic liberalization is lower than the steady-state rate, the transitional price after domestic liberalization is higher than the transitional price after international liberalization. The asset price cycle can still occur, however. The price must fall in the second period after liberalization; whether the price rises in the first period depends upon parameters in a manner similar to the case of domestic liberalization.

In addition, since the world interest rate exceeds the transitional rate that would apply in a closed economy, there are capital outflows in the transitional period. Asset prices can cycle despite the international lending. In the second period after liberalization, there are capital inflows as debt is retired. After that, there is no international borrowing or lending.

4.1 EQUILIBRIUM IN THE TRANSITIONAL PERIOD

I assume that domestic houses have no utility value for foreign residents, so they will not be traded internationally.⁹ In addition, I assume that nondurable goods are homogenous across the world.

Since the world rate of interest is assumed to be the unregulated, steady-state rate, the economy must move to the unregulated steady-state in the second period after international liberalization. Members of the old generation who own houses in the transitional period borrow fully against them, so there is no transfer of wealth to members of the young generation in the second period after liberalization. At the steady-state interest rate, the price that makes members

⁹There will be no international trade in houses as long as there are no pure arbitrage opportunities for international investors. These are ruled out, however, by domestic equilibrium.

of the young generation indifferent between buying and not buying a house is the steady-state price.

The price in the transitional period is determined by the indifference condition for members of the young generation in the transitional period. The consumption profiles (28) derived for the transitional period after domestic liberalization apply in this case, if the steady-state interest rate, r^* , is substituted for the transitional rate, r . Substituting these consumption levels into the simplified indifference condition in (7) and solving for the price,

$$P = \frac{P^*}{x} \quad (33)$$

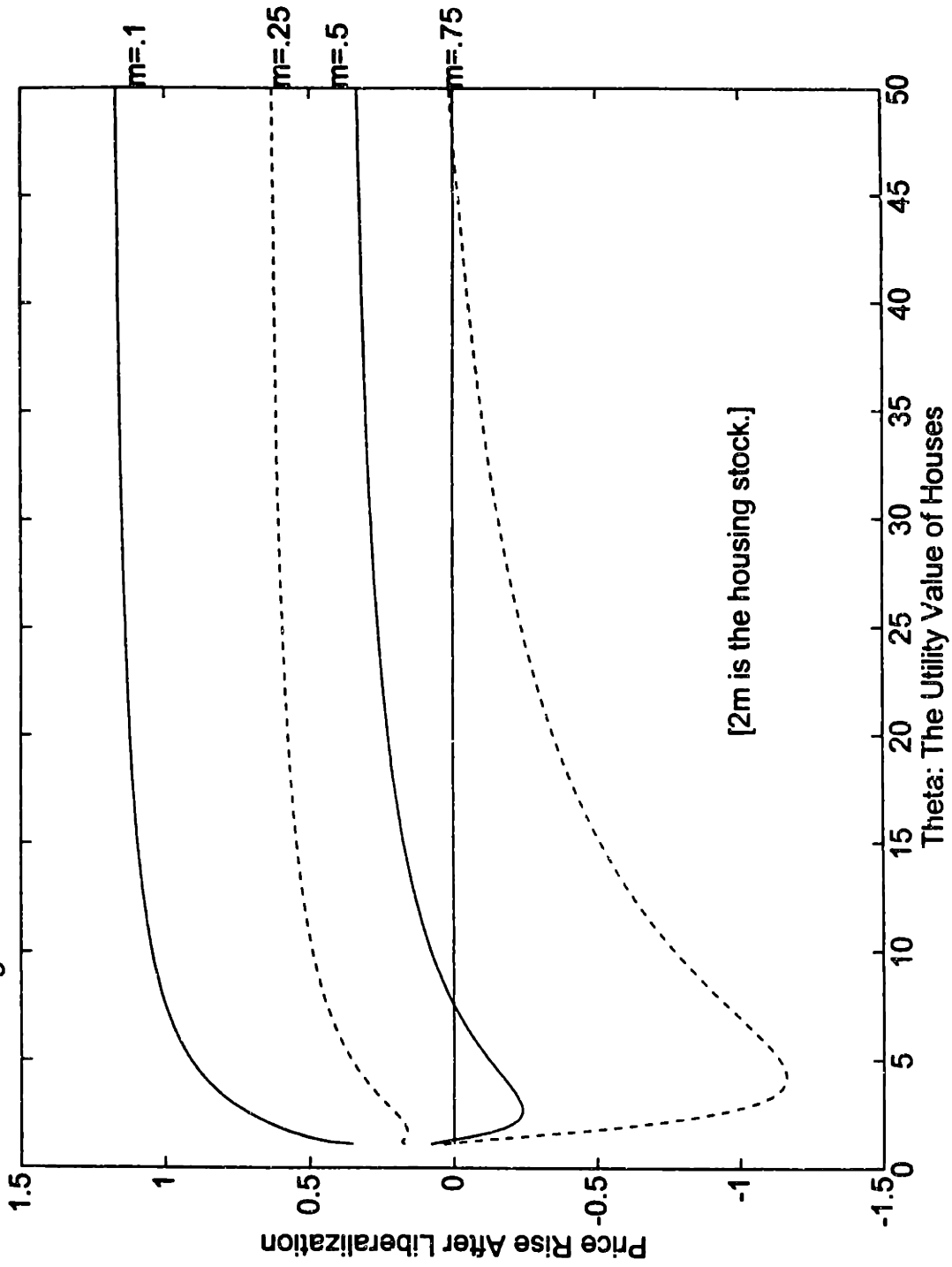
4.2 THE ASSET PRICE CYCLE

From (33), the price in the transitional period must exceed the steady-state price, since $x < 1$. So prices fall in the second period after international liberalization. Comparing the transitional price after international liberalization to the corresponding price after domestic liberalization, it is clear from (30) and (33) that the price is higher after domestic liberalization (recall that $r < r^*$ in (30)). An asset price cycle is still possible, however. Figure 4 plots the difference between the transitional price after international liberalization and the fully-regulated price. The pattern is broadly similar to the case after domestic liberalization, and the intuition for the effects of parameters is the same.

4.3 CAPITAL FLOWS

From the budget constraint listed in the derivation of (29), it is clear that an increase in the transitional interest rate will reduce total consumption of nondurables during the transitional

Figure 4: The Price Boom After International Liberalization



period. (Note that the transitional price has no effect on total consumption in the transitional period.). As such, since the transitional rate after domestic liberalization cleared the market for nondurables, the higher world rate implies less total consumption than the aggregate endowment, and hence capital outflows (and a current account surplus). In the second period after liberalization, lenders from the transitional period will retire their debt (capital inflows) and consume the interest payments from foreign borrowers (leading to a current account deficit). After that, the economy will neither lend nor borrow abroad.¹⁰

Unlike the typical story about international financial liberalization, in which capital inflows drive asset prices, the model in this paper produces capital outflows after liberalization. These flows tend to dampen the asset price cycle, but they do not eliminate it. Although in practice the elimination of capital controls may have broader effects than fixing the interest rate at the world rate, these results suggest that liberalization has fundamental effects on the domestic economy sufficient to generate asset price dynamics, even in the absence of a significant international dimension.¹¹

¹⁰One might object here that the world rate of interest could well be lower than the autarky rate for small open economies. A natural benchmark for the world rate is $r^* = 0$, given a zero discount rate. In this case, one can show that total consumption will always exceed the endowment in the transitional period, so there will be external borrowing. The asset price also becomes a certainty if the world interest rate is low enough

¹¹The result that the world rate of interest exceeds the domestic rate after domestic liberalization depends on the assumption that consumers cannot adjust housing consumption when old. I note in the Appendix that the world rate is typically lower than the domestic rate after domestic liberalization when consumers may buy and sell houses in either period of life.

5. DISCUSSION

5.1 EXTENSIONS

The framework I have established in this paper could be extended in several ways to encompass other policy experiments or macroeconomic variables. One could consider, for example, the effects of an anticipated liberalization. Starting from an initial position of a fully-regulated economy, an announcement of liberalization in the next period would make the purchase of a house more attractive (because of the opportunity to borrow against it in the future) and increase the price. Whether this would be sufficient to eliminate an asset price cycle that would otherwise occur depends on parameter values.

Another possible extension would be to consider macroeconomic fluctuations by incorporating a shock to the endowment of nondurables. External shocks are particularly important to small open economies, whose experiences have motivated this paper. A temporary positive shock in the transitional period after liberalization would tend to amplify the price cycle.

5.2 DOWNPAYMENTS, REAL INTEREST RATES, AND CURB MARKETS

A traditional view of financial repression is that a combination of fixed nominal interest rates (or rate ceilings) and high inflation creates a policy of low real interest rates, at least in the official sector.¹² Financial liberalization in such circumstances often leads to increases in the measured real rate of interest. In many such cases, however, the pre-liberalization period is marked by an unofficial, “curb” market for credit, with interest rates much higher than the official, quoted rates.

¹²See Fry (1995), and Galbis (1993) for descriptions of this view.

With respect to the model in this paper, with a binding downpayment constraint there exists a shadow real interest rate at which borrowing and lending would take place at the margin. Purchasers of houses would be willing to pay a high rate to get some consumption smoothing, and nonpurchasers would of course be willing to lend at a higher rate. This shadow rate corresponds to a curb rate. The diversion of some funds into an unofficial market for credit would have the effect of limiting the difference in price between the regulated and unregulated markets.

5.3 POLICY REFORM AND CREDIT MARKETS

The argument of this paper can be tied to the larger literature on policy reform for developing countries. Many authors have noted, for example, that exchange-rate stabilization experiments are often followed by consumption booms. One explanation for this phenomenon is that stabilization remonetizes an economy, and thus makes credit markets more liquid, allowing more consumer borrowing to finance consumption. Copelman (1994) provides some evidence for this notion. To the extent that remonetization acts on credit markets, it is consistent in spirit with the story of this paper about fluctuations being driven by previously repressed demand for consumer credit. In this sense, ineffective monetary policy and restrictions on credit markets have similar effects.

More generally, Rebello and Vegh (1995) have outlined a set of stylized facts associated with stabilization experiences, and built a framework to evaluate competing theories. Some of the facts have to do with booms and busts in real estate prices and the economy generally. Since exchange rate stabilizations have often occurred contemporaneously with financial reform, the

stylized facts about the two policies are closely related. Rebelo and Vegh examine five sets of hypotheses that attempt to explain experiences with stabilization. These are: sticky wages, sticky inflation, temporary policy, supply-side effects of credible disinflation, and expansionary fiscal contractions. Simulating a model economy under alternative assumptions, Rebelo and Vegh find that three of the hypotheses--sticky wages, sticky inflation, and temporariness--can produce booms and busts in output. They do not report asset prices.

As noted by Sachs (1995), one element missing from the Rebelo and Vegh framework is a role for changing credit market conditions. In particular, they maintain the assumption of perfect credit markets throughout the analysis. In this regard, although this paper looks at asset prices and not output, it formalizes an alternative hypothesis about booms and busts--namely that they can be driven by liberalization of financial markets. As I have noted, one could think of remonetization of the economy as a kind of financial liberalization.

6. CONCLUSION

I have argued that financial deregulation can create cycles in the price of houses as a result of a repressed demand created by restrictions on consumer borrowing. Although other aspects of credit markets or macroeconomic shocks might affect this cycle in important ways, these elements are not required to generate asset price cycles. Moreover, the asset price cycle is not an artifact of capital inflows. It can occur regardless of whether there are capital controls during the transition to a deregulated economy.

The message of the paper is simple. Ordinary consumption smoothing motives are sufficient to generate interesting asset price dynamics after financial liberalization.

APPENDIX

In the text, I assumed that consumers could not adjust their housing decisions when old. In this appendix, I explore the implications of relaxing this assumption. I show that the regulated equilibrium can be supported for a wide range of parameters. In the unregulated case, the equilibrium in the text will not be supported. Instead, there are two possible steady states. If $m < 1/2$, steady state will entail no one buying when young and a measure $2m$ of consumers buying when old. If $m > 1/2$, a measure $2m-1$ will buy when young and keep the house when old, and a measure $2(1-m)$ will wait until old to buy. Transitional dynamics after liberalization are more problematic. Starting from the regulated steady state derived in the text, $m < 1/2$ implies that there is no equilibrium in the transitional period after liberalization such that the economy eventually moves to a steady state. If $m > 1/2$, the boom-bust cycle occurs under qualitatively similar parameter circumstances to the case in the text. For most other parameter ranges, prices fall for two periods, as in the text. It is possible, however, that prices for two periods, or that prices first fall, then rise. However, the parameter regions in which the latter scenarios occur would not support the fully-regulated equilibrium, so they may not be relevant.

The restriction that $m > 1/2$ means simply that one generation cannot consume the entire stock of houses. This restriction arises because the discreteness of house consumption and the fixed housing supply make it impossible to clear the market for houses after liberalization. If housing supply rose with the price, or if house construction were constrained by credit restrictions, liberalization might lead to an increase in the supply of houses sufficient to produce an equilibrium if $m < 1/2$. Since house construction is not an element of my model, I can only conjecture.

Once the restriction on housing adjustment is relaxed, there are four housing strategies available to consumers: (1) buying when young and keeping when old-- "buy-buy," (2) buying when young and selling when old -- "buy-not," (3) not buying when young, but buying when old -- "not-buy," and (4) never buying-- "not-not." A steady state is defined by indifference between two of these housing options. Proving that a steady state exists for given parameter values entails ensuring that the other two housing options are less attractive to the consumer than the ones that defined equilibrium, at the steady state prices and interest rates. I first analyze steady states in the regulated and unregulated economies, then turn to dynamics after liberalization.

A.1 FULLY-REGULATED STEADY STATE

Equilibrium was defined in the text by indifference between the buy-buy and not-not strategies. The consumption path and lifetime utility associated with buy-buy was derived in Section 2. After exponentiating, this utility is given by:

$$U^{bb}=(1-(1-m)P)\theta^2 \quad (\text{A1})$$

Utility from the other strategy that defined equilibrium--not-not--is given by:

$$U^{nn}=(1+mP) \quad (\text{A2})$$

Consider the buy-not strategy. Since borrowing is impossible in the first period, this strategy entails a consumption path of $c_y=1-(1-m)P$ and $c_o=1+P$. Hence, utility from this strategy is given by:

$$U^{bn}=(1-(1-m)P)(1+P)\theta \quad (\text{A3})$$

Finally, consider the strategy not-buy. After solving optimally for this strategy, allowing consumers to lend at the steady-state, fully-regulated interest rate when young, and substituting for the steady-state interest rate, the utility associated with this strategy can be expressed as:

$$U^{nb} = (1 + mP) \left(1 - \frac{P}{2}\right)^2 \theta \quad (\text{A4})$$

The inequality $U^{bb} > U^{bn}$ creates one condition for equilibrium, namely $P < \theta - 1$. The second condition follows directly from $U^{nn} > U^{nb}$, which implies:¹³

$$P > 2 \left(1 - \frac{1}{\sqrt{\theta}}\right) \quad (\text{A5})$$

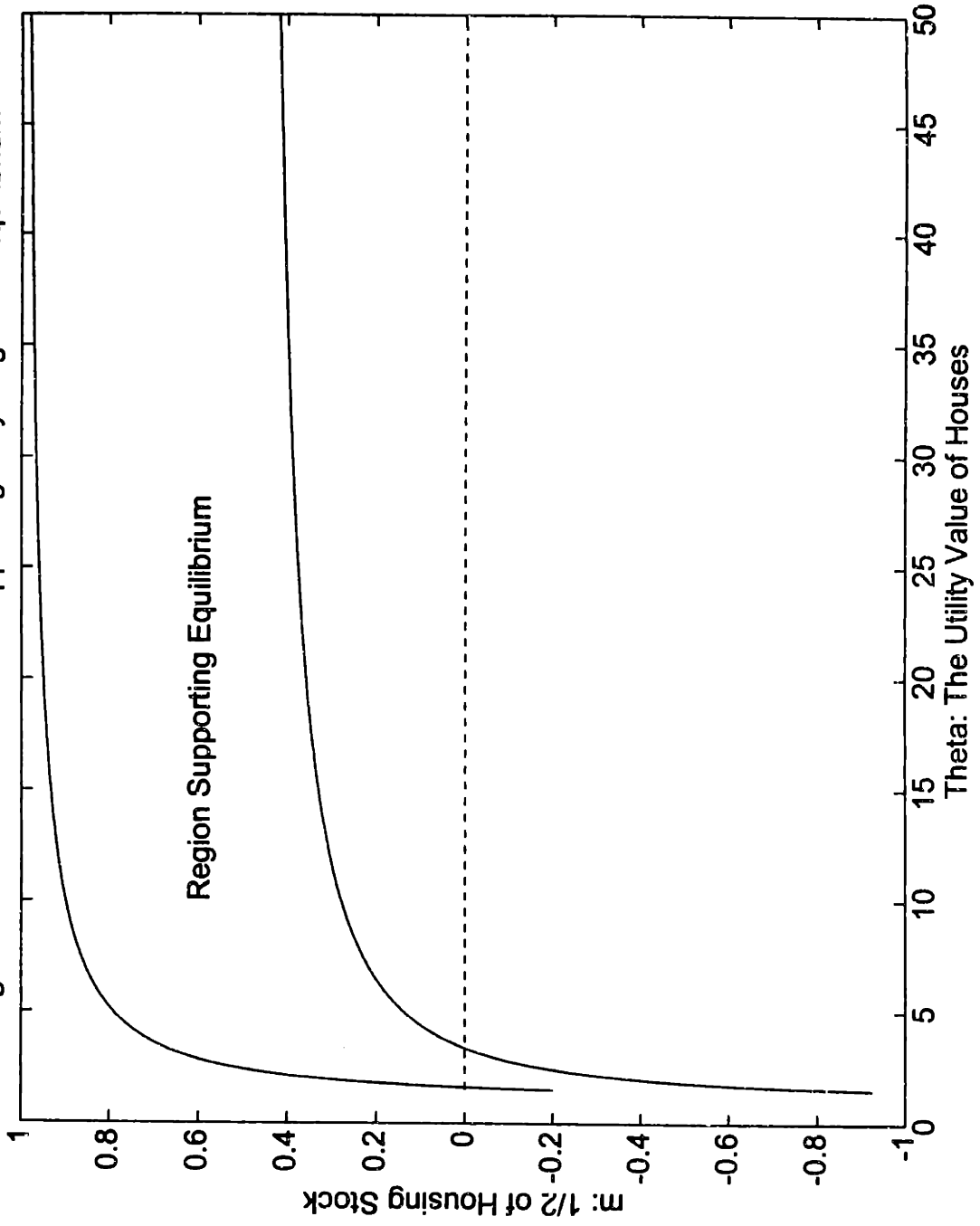
Substituting for the steady state value of P in (13), one can reexpress the conditions on P as conditions on m :

$$\frac{\theta^2}{\theta^2 - 1} - \frac{\sqrt{\theta}}{2(\sqrt{\theta} - 1)} < m < 1 - \frac{\theta}{\theta^2 - 1} \quad (\text{A6})$$

The inequalities in (A6) are graphed in Figure A1. The parameter region supporting the equilibrium derived in the text is indicated.

¹³Note that young-period consumption for the not-buy strategy is $(1 + mP)^2 (1 - P/2)^2$. Given logarithmic utility, $P < 2$ is required for this strategy to be viable. Condition (A5) means that $P < 2$ is not sufficient for this strategy to be preferable to never buying at the fully-regulated equilibrium derived in the text. P must be sufficiently lower than 2.

Figure A1: Parameter Values Supporting Fully-Regulated Equilibrium



A.2 UNREGULATED STEADY STATE

A.2.1 UTILITY FROM AVAILABLE HOUSING STRATEGIES

The equilibrium in the text equated lifetime utilities associated with the buy-buy and not-not strategies. Consumption paths associated with these strategies were derived in Section 2. Substituting into lifetime utility and exponentiating,

$$U^{nn} = (1+r) \left(\frac{2+r}{2(1+r)} \right)^2 \quad (\text{A7})$$

$$U^{bb} = (1+r) \left(\frac{2+r}{2(1+r)} - \frac{P}{2} + \frac{P}{2(1+r)^2} \right)^2 \theta^2$$

where the expressions in parentheses are young-period consumption levels corresponding to each strategy. After solving for optimal consumption associated with the other strategies--buy-not and not-buy--and substituting into lifetime utility,

$$U^{bn} = (1+r) \left(\frac{2+r}{2(1+r)} - \frac{P}{2} + \frac{P}{2(1+r)} \right)^2 \theta \quad (\text{A8})$$

$$U^{nb} = (1+r) \left(\frac{2+r}{2(1+r)} - \frac{P}{2(1+r)} + \frac{P}{2(1+r)^2} \right)^2 \theta$$

where, again, the expressions in parentheses are young-period consumption levels.

A.2.2 UNSUSTAINABILITY OF UNREGULATED EQUILIBRIUM EQUATING ALWAYS BUY AND NEVER BUY STRATEGIES

From (A8), $U^{bn} < U^{nb}$ for $r > 0$. With a zero discount rate, the timing of the house purchase has no effect on lifetime utility from consumption of the house. Instead, the timing affects the

ability to borrow against the house to finance consumption of nondurables. A strategy of buying when young and selling when old requires the consumer to satisfy a more stringent lifetime budget constraint than waiting until the second period to buy, since consumers are able to borrow against the house in the old period of life. Thus, to ensure that the equilibrium in the text is supported, it must be true that $U^{nb} < U^{bb}$. After substituting for the equilibrium price and rearranging, this condition reduces to

$$1 + r < \frac{1}{\sqrt{\theta}} \quad (\text{A9})$$

Condition (A9) is always false for positive r . Thus, the equilibrium in the text is never supported, and other equilibria must be considered. Given $U^{bn} < U^{nb}$ for positive r , there are only two possibilities. If $m < 1/2$, steady-state is given by $U^{nn} = U^{nb}$, with a measure $1 - 2m$ of consumers never buying a house, and a measure $2m$ buying when old. If $m > 1/2$, steady-state is given by $U^{bb} = U^{nb}$, with a measure $2m - 1$ of consumers buying a house when young and keeping it when old, and a measure $2(1 - m)$ waiting until old to buy. The case where $m = 1/2$ is a knife-edge where either steady state is possible.

A.2.3 UNREGULATED STEADY-STATE WHEN $m < 1/2$

As in the derivation in the text, three conditions must be imposed for an equilibrium: (1) market-clearing in houses, (2) market clearing in nondurables, and (3) indifference between the appropriate housing options. Given the unsustainability of the equilibrium derived in the text, the only steady-state possibility for $m < 1/2$ is that a measure $1 - 2m$ never buy a house and a measure $2m$ buy only when old. This satisfies market clearing in houses and requires (by

indifference) that $U^{nn}=U^{nb}$. As in the derivation in the text, this indifference condition has a simplified form, namely $c^{nn}=\theta^{1/2}c^{nb}$, where c refers to young-period consumption. Substituting appropriate consumption levels (which can be read from (A7) and (A8)) into this simplified condition and rearranging gives a solution for the price as a function of the real interest rate:

$$P = \frac{(2+r)(1+r)(\sqrt{\theta}-1)}{r\sqrt{\theta}} \quad (\text{A10})$$

Using the simplified form of the indifference condition, the market clearing condition for nondurables can be solved for the real interest rate:

$$(1-2m)[c^{nn}+(1+r)c^{nn}] + 2m[c^{nb}+(1+r)c^{nb}] = 2$$

$$\frac{\bar{x}(2+r)^2}{1+r} = 2$$

$$r = \frac{2\left((1-\bar{x}) + \sqrt{1-\bar{x}}\right)}{\bar{x}} \quad (\text{A11})$$

where $\bar{x} = [(2m) + \theta^{1/2}(1-2m)]/\theta^{1/2}$, and c refers to young-period consumption associated with the appropriate housing strategy (superscript).

For this equilibrium to be sustainable, U^{nn} must be greater than U^{nb} . Given the form of the price solution when these two utilities are equated (derived in the text), this condition is satisfied when $P > (1+r)(\theta-1)/(r\theta)$. From (A10), this condition reduces to $r > \theta^{-1/2}$. Since r increases with θ , this condition is satisfied for θ greater than some minimum value. The minimum value of θ will depend on m . Since r increases with m , the minimum value of θ will fall with m .

A.2.4 UNREGULATED STEADY-STATE WHEN $m > 1/2$

When $m > 1/2$, steady state requires that a measure $2m-1$ of consumers always buy houses, and a measure $2(1-m)$ buy when old. So the indifference condition is $U^{bb} = U^{nb}$, which simplifies to $c^{nb} = \theta^{1/2} c^{bb}$, where c refers to young-period consumption. Substituting appropriate consumption levels into the simplified indifference condition and solving for the price of houses:

$$P = \frac{(2+r)(1+r)(\sqrt{\theta}-1)}{r[(2+r)\sqrt{\theta}-1]} \quad (\text{A11})$$

Substituting the simplified indifference condition into the market-clearing condition for nondurables, using expressions for c^{nb} (in (A8)) and P (A11), and solving for r :

$$\begin{aligned} 2(1-m)[c^{nb} + (1+r)c^{nb}] + (2m-1)[c^{bb} + (1+r)c^{bb}] &= 2 \\ \bar{x}(2+r)c^{nb} &= 2 \\ r &= \frac{2\left((1-\bar{x}) + \sqrt{1-\bar{x}}\right)}{\bar{x}} \end{aligned} \quad (\text{A12})$$

where $\bar{x} = [2m-1 + 2(1-m)\theta^{1/2}]/\theta$, and c refers to young-period consumption associated with the appropriate housing strategy (superscript).

For this equilibrium to be sustained, U^{nn} must be less than U^{bb} , which requires $P < (1+r)(\theta-1)/(r\theta)$. Using the solution for the price in (A11), this condition reduces to $1 < (2+r)\theta^{1/2}$, which must be true. So the equilibrium is sustained for all values of θ .

A.3 TRANSITIONAL DYNAMICS

I assume that the regulated economy is in a steady state with a measure m of each generation buying a house when young and keeping it when old, and a measure $1-m$ never buying a house. In addition, I assume that the economy moves to its unregulated steady state two periods after liberalization. The appropriate steady state will depend on the value of m , as described in Section A.2.

A.3.1 TRANSITIONAL DYNAMICS WHEN $m < 1/2$

First I prove that if the unregulated economy ever reaches steady state it is always in steady state, and then that there is no equilibrium during the transitional period after international liberalization consistent with steady state equilibrium two periods after liberalization. Finally, I find the conditions for a possible equilibrium after domestic liberalization, and discuss simulation results that rule out this possibility.

PROPOSITION A.1: If $m < 1/2$ and the unregulated economy ever reaches steady state, then the unregulated economy is always in steady state.

Proof: Suppose the unregulated economy reaches its steady state in some time period. By the results in Section A.2, steady state entails a measure $2m$ of consumers buying houses when old and a measure $(1-2m)$ never buying. In the previous period, young consumers must have adopted the same housing strategies in the same proportions. Otherwise, with $m < 1/2$, given any measure of house holdings by the old generation in the previous period, market clearing in houses would have required members of the young generation (in the previous period) to be

indifferent between three housing strategies. Since there are only (at most) two unknowns (current price and interest rate) in the previous period, there will not be a solution, except for special parameter circumstances.

Thus, if the unregulated economy ever reaches its steady state, young generations in every previous period will adopt the steady-state housing strategies. Note that total consumption by each generation can be written as a function of the consumption of those who never buy, since, by the indifference condition, consumption of those who buy when old is a function of consumption by those who never buy. Consumption of those who never buy is a function only of the current period real interest rate. Thus, in the hypothetical period in which the economy reaches its (unique) steady state, the previous period's real interest rate, which determines consumption of the old, must equal the steady-state value of the real interest rate. This must be true for every previous period as well. The steady-state interest rate pins down the price at its steady-state value.

Thus, if the unregulated economy ever reaches its steady state, every previous period in the unregulated economy is also in steady state.▲

PROPOSITION A.2: If $m < 1/2$ and the unregulated economy ever reaches steady state, there is no equilibrium in the transitional period after international liberalization of the fully-regulated economy.

Proof: Suppose the economy starts in its fully-regulated steady-state and is “internationally” liberalized, *i.e.*, domestic credit restrictions and international capital controls are eliminated simultaneously. By Proposition A.1, if the economy ever reaches steady state, it

does so two periods after liberalization. Given the form of steady state for $m < 1/2$, no one will buy when young. This implies that in the first period after liberalization, the transitional period, some young consumers must be planning to buy when old and some not (since $m < 1/2$).

Now consider the lifetime utility associated with various housing strategies during the transitional period. After solving for the optimal nondurable consumption path associated with each strategy, the appropriate lifetime utilities (after exponentiating) can be written as follows:

$$\begin{aligned}
 U^{bb} &= (1+r) \left(\frac{2+r}{2(1+r)} - \frac{(1-m)P}{2} + \frac{P^*}{2(1+r)(1+r^*)} \right)^2 \theta^2 & (A13) \\
 U^{nn} &= (1+r) \left(\frac{2+r}{2(1+r)} + \frac{mP}{2} \right)^2 \\
 U^{nb} &= (1+r) \left(\frac{2+r}{2(1+r)} + \frac{mP}{2} - \frac{r^*P^*}{2(1+r)(1+r^*)} \right)^2 \theta \\
 U^{bn} &= (1+r) \left(\frac{2+r}{2(1+r)} + \frac{P^*}{2(1+r)} - \frac{(1-m)P}{2} \right)^2 \theta
 \end{aligned}$$

where variables without asterisks are at their value in the transitional period and variables with asterisks are at their steady-state value. By assumption, the regulated economy is in a steady state with a measure m of each generation buying a house when young and keeping it when old, and a measure $1-m$ never buying a house. So members of the young generation have mP in initial assets from the estates of the preceding old generation.

Substituting the steady-state price (A10) into the expressions in (A13), it is straightforward to show that $U^{nn} < U^{nb}$ when $r = r^*$ (which is true after international liberalization) and that $U^{bn} < U^{nb}$ if $P(1+r) > P^*/(1+r^*)$, which must be true to rule out arbitrage. This rules out all

housing strategies which involve not buying (or selling) a house in the old period of life. So every member of the young generation in the transitional period must be planning to buy a house when old. Since $m < 1/2$, this cannot be an equilibrium.

Thus, if the unregulated economy ever reaches its steady state, $m < 1/2$ implies that there is no equilibrium in the transitional period after liberalization.▲

Finally, consider domestic liberalization. Suppose the economy eventually reaches steady state. By Proposition A.1, it must reach steady state two periods after liberalization. By the proof of Proposition A.2, $U^{bn} < U^{nb}$ during the transitional period.. It is possible after domestic liberalization, however, than $U^{nn} > U^{nb}$ during the transitional period. In this case, potentially there is an equilibrium equating the strategies of never buying a house and buying when young and keeping when old. In particular, given that steady state involves no one buying when young, a transitional equilibrium would require a measure $2m$ of young consumers to follow the buy-buy strategy and a measure $(1-2m)$ to never buy. Since the young generation would buy all the houses in the transitional period, the price must be such that no members of the old generation in the transitional period want houses.

Consider the old generation during the transitional period. Those who own houses have nondurable consumption of their endowment (one) plus borrowing against the house (limited by its future value P^*) and enjoy utility from consuming the house. Those who own and sell lose the utility from house consumption but gain the price of the house in nondurable consumption. Thus, old owners will keep their houses as long as $[1 + P^*/(1+r)]\theta > (1+P)$. By similar reasoning,

old nonowners will not buy as long as $(1-P + P^*/(1+r))\theta < 1$.¹⁴ Putting these conditions together, old owners will keep their houses and old nonowners will not buy if

$$p \equiv \frac{\theta - 1}{\theta} + \frac{P^*}{1+r} < P < (\theta - 1) + \frac{\theta P^*}{1+r} = \theta \bar{p} \equiv \bar{p} \quad (\text{A14})$$

Every member of the old generation will want a house if $P < p$; no one in the old generation will want a house if $P > \bar{p}$.

The form of the proposed equilibrium requires that $U^{nn} = U^{bb}$ in the transitional period and that $P > \bar{p}$, so that no one in the old generation will want a house during the transitional period. I have solved for the price and real interest rate during the transitional period, under the assumptions that $U^{nn} = U^{bb}$ and no members of the old generation want a house. Using simulations, I have found no parameter values such that $P > \bar{p}$. Thus, the equilibrium cannot be supported.

A.3.2 TRANSITIONAL DYNAMICS WHEN $m > 1/2$

By assumption, the economy will move to unregulated steady state two periods after liberalization. For $m > 1/2$, this steady state is characterized by a measure $2(1-m)$ waiting until old to buy, and a measure $2m-1$ buying when young and holding the house when old. As a result, equilibrium in the transitional period after liberalization requires that every member of the young generation plan to buy (or hold) a house when old. Thus, equilibrium imposes $U^{nb} = U^{bb}$. The

¹⁴Note that those who buy houses in the transitional old generation can also borrow against them.

precise proportion of consumers in the young generation who choose to buy will depend the decisions of the old generation during the transition, which depends on the price.

If $\underline{p} < P < \bar{p}$, a measure m of the old generation will want a house, so a measure of the young generation will buy. Call this the base case.

Consider international liberalization. If $P < \underline{p}$, everyone in the old generation will want a house, so a measure $2m-1$ must buy. With the interest rate fixed, this case differs from the base case only with respect to the size of capital flows, since total consumption is affected by the proportion of consumers in each housing strategy. If $P > \bar{p}$, no one in the old generation would want a house, which cannot be an equilibrium. Fortunately, simulations (below) reveal that this case never occurs after international liberalization.

Now consider domestic liberalization. Suppose $P < \underline{p}$ at base case real interest rates. Then three variables--the real interest rate, the price, and the proportion of young consumers who buy--will adjust to satisfy three conditions-- $P = \underline{p}$, $U^{nb} = U^{bb}$, and market-clearing in nondurables.

Likewise, if $P < \bar{p}$ at base case real interest rates, the variables will adjust so that $P > \bar{p}$.

Equating U^{nb} and U^{bb} gives a solution for price in terms of the real interest rate.

$$P = \frac{(2+r)(\sqrt{\theta}-1) + \frac{P \cdot (\sqrt{\theta}-r)}{1+r}}{(1+r)[m + \sqrt{\theta}(1-m)]} \quad (\text{A15})$$

After international liberalization, the real interest rate is the world rate, assumed to be the steady-state rate for an unregulated economy given in (A12). After domestic liberalization, the real interest rate is adjusted so the market for nondurables clears. Consider the base case where the initial measure m of owners in the transitional old generation keep their houses and the

nonowners in the old generation do not buy. After substituting the indifference condition, market clearing in nondurables can be written as follows:

$$m\left[1 + \frac{P^*}{1+r}\right] + (1-m)[1] + \bar{x}[c^{nb}] = 2$$

where $\bar{x} = [m + (1-m)\theta^{1/2}]/\theta^{1/2}$ and the first two terms reflect consumption of old generation owners (who borrow against a house) and nonowners (who consume only their endowment) in the transitional period. Substituting for c^{nb} (the value can be read from (A13)) and rearranging gives a solution for the real interest rate:

$$r \left(2 - \bar{x} - \frac{(1-\bar{x})}{\bar{x}} \right) = \frac{P^* \left[2m\bar{x}\sqrt{\theta}(1+r^*) + m(\sqrt{\theta}-r^*) - r^* \bar{x}^2 \sqrt{\theta} \right] - 2(1-\bar{x}) + \frac{2m(\sqrt{\theta}-1)}{\bar{x}\sqrt{\theta}}}{\bar{x}\sqrt{\theta}(1+r^*)}$$

With these solutions, I can consider the effects of financial liberalization. First, compare steady-state prices in the fully-regulated and unregulated economies. Figure A.2 plots the unregulated price minus the regulated price for various parameter values. For low values of m (close to $\frac{1}{2}$), the unregulated price exceeds the regulated price for all values of θ . For higher values of m , unless θ is close to one, the regulated price will be higher. Since the fully-regulated steady state requires that θ exceed a minimum value, small values of θ may not be relevant. The comparison between regulated and unregulated prices is consistent with the case in the text. When m is large, feedback effects are large in the regulated economy (tending to increase the price), but interest rates are large in the unregulated economy (tending to decrease the price).

Considering the dynamics after international liberalization, Figure A.3 plots the initial boom for various parameter values and Figure A.4 plots the bust. The boom region is also

Figure A2: Unregulated Minus Regulated Prices When $m > 1/2$

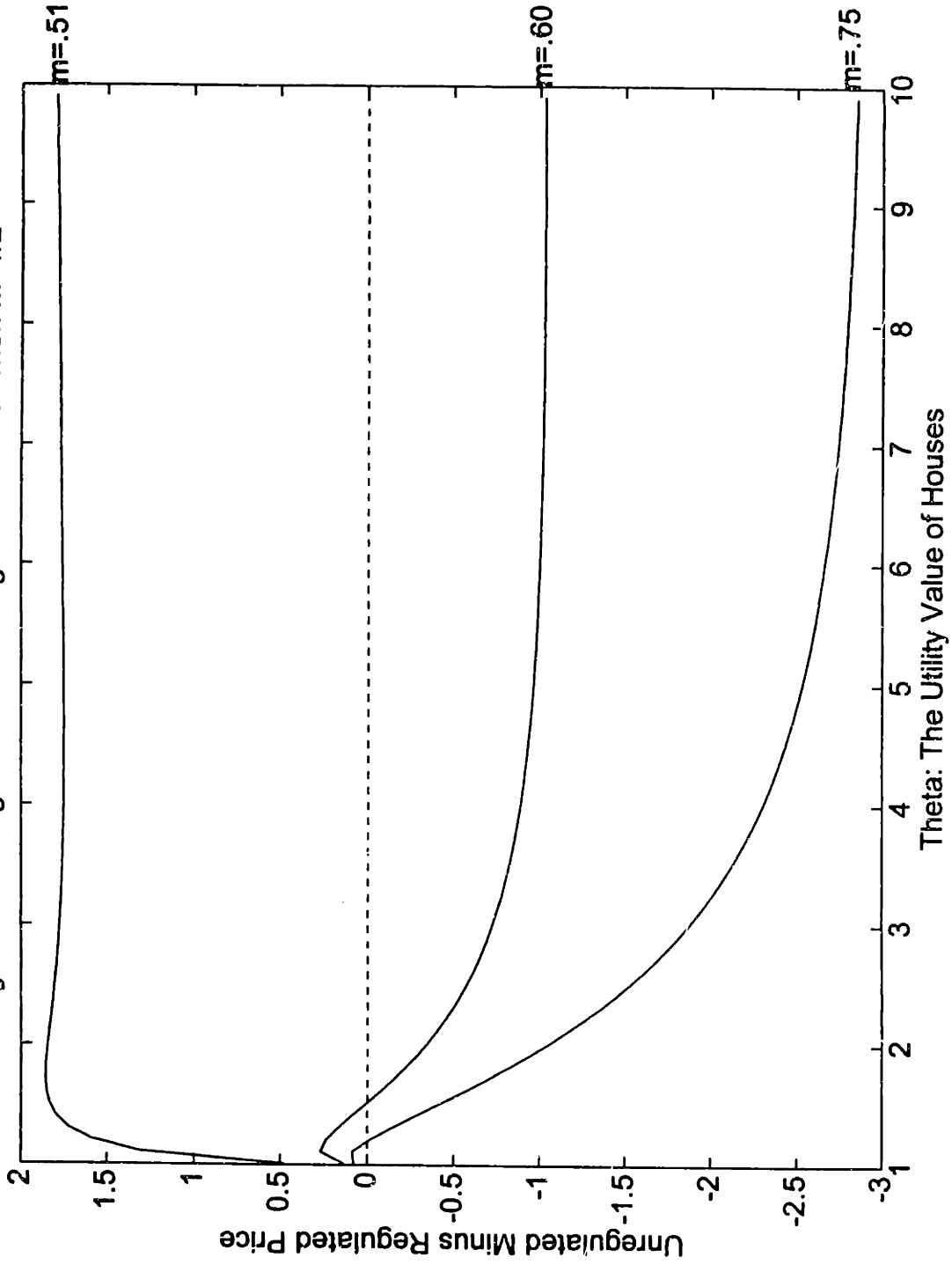
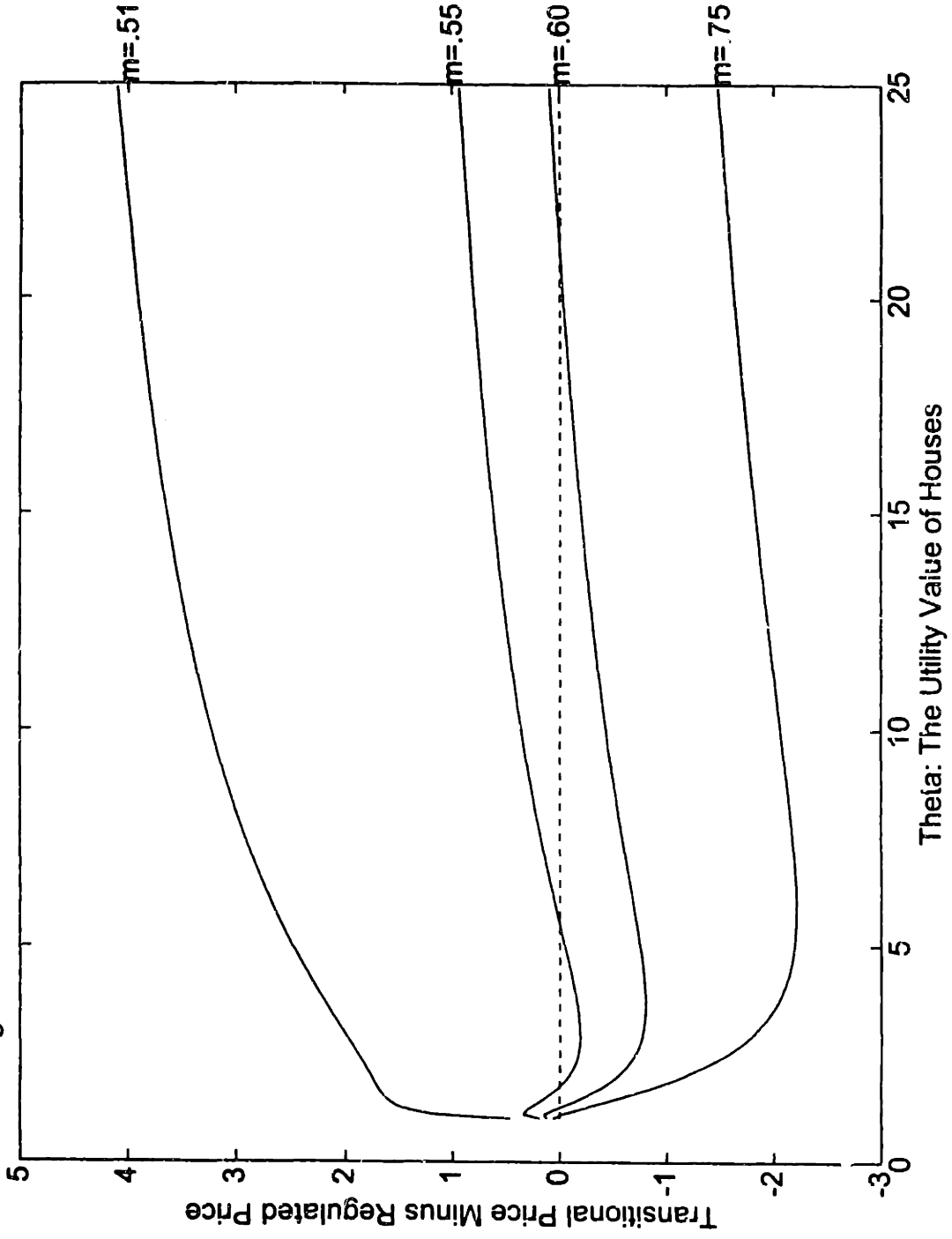
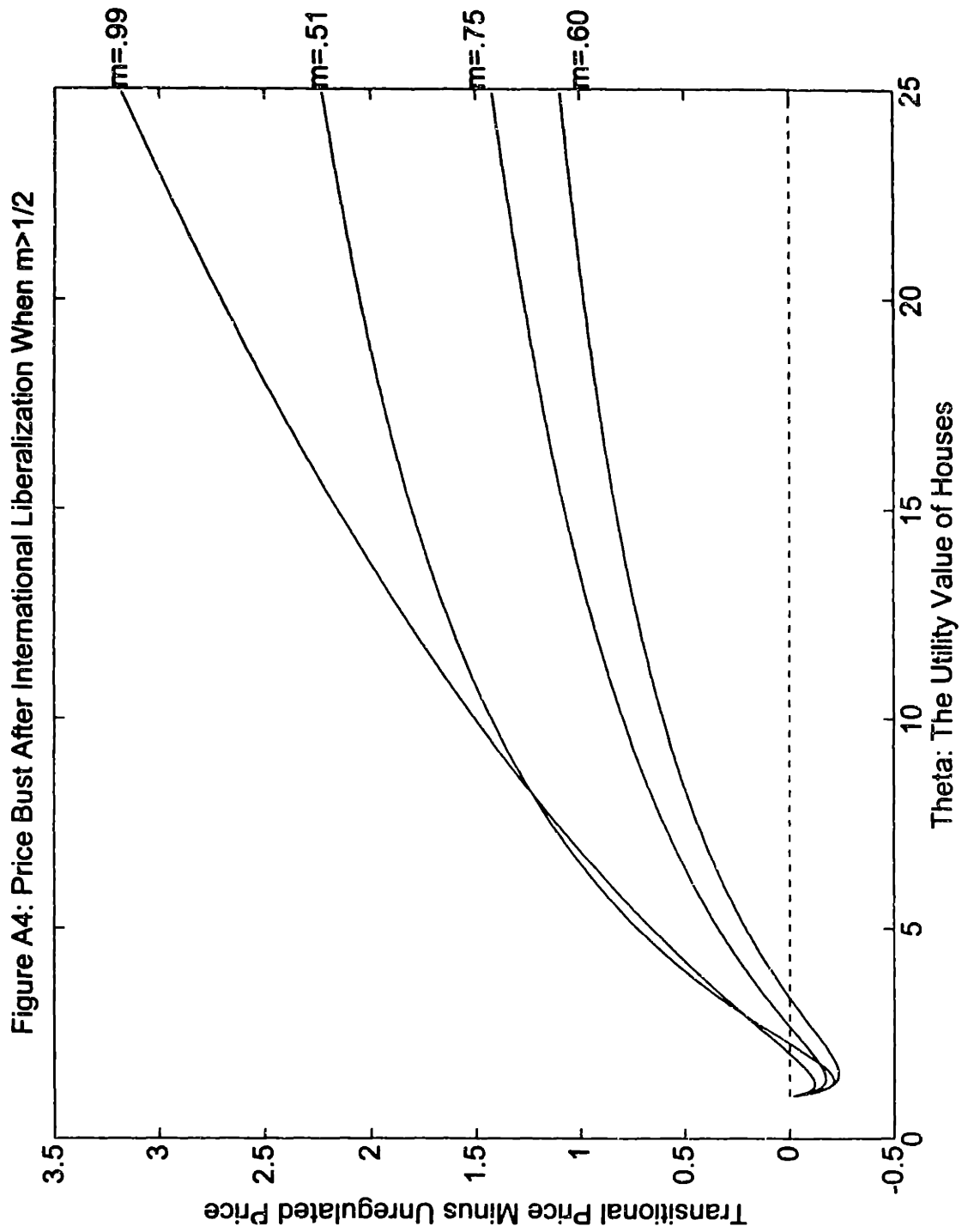


Figure A3: Price Boom After International Liberalization When $m > 1/2$





consistent with the text. When m is low enough, the boom always happens. As m increases, the boom occurs if θ falls outside an intermediate region. Again, since the smaller values of θ do not support the regulated equilibrium, it may be more relevant to think of a critical minimum level of θ (the upper end of the intermediate region) above which the boom occurs. In other words, if consumers like houses enough, the boom happens.

The bust regions indicated in Figure A.4 are completely consistent with the text if small values of θ , which do not support the regulated equilibrium, are ignored. If θ is large enough, the bust always happens. For smaller values of θ , the price may rise after the transitional period, which means prices after liberalization may rise for two periods, or even fall first, and then rise.

Overall, price dynamics after international liberalization seem consistent with the story in the text. Considering domestic liberalization, simulations reveal that the price in the transitional period will hit its upper bound for a low range of θ if m is small (near $\frac{1}{2}$), and for a much higher range of θ if m is large. In these cases, it is necessary to solve for the real interest rate that equates the price with its upper bound, then use this rate to find the price level. In order to avoid this complication, I will plot parameter regions of m and θ for which P falls short of the upper bound. With respect to the lower bound, if P would drop below this bound, I simply substitute the lower bound, which does not depend on the current period interest rate.

Figure A.5 plots the price boom after liberalization. The picture is similar to the one in the text. If m is small enough, the boom always occurs; otherwise it occurs if θ falls outside an intermediate range. The bust, plotted in Figure A.6 always occurs if θ is not too close to one. Again, small values of θ would not support the fully-regulated equilibrium.

Unlike the case in the text, however, simulation reveals that the real interest rate in the transitional period after domestic liberalization is typically higher than the world rate. Given m , however, the critical region of θ which rules out a boom after domestic liberalization is smaller than the corresponding region after international liberalization. This is because equilibrium puts a floor on the price after domestic liberalization, but not after international liberalization.

A.4 SUMMARY

For $m > 1/2$, price dynamics after financial liberalization are similar in qualitative terms regardless of whether consumers are allowed to adjust housing decisions when old. For $m < 1/2$, there is no transitional equilibrium that will allow the economy to move to a steady state after liberalization. I take the results as supportive of the simplification in the text as a means to understand the effects at work in the model. The restriction on m arises as a result of discreteness in consumption of houses and a fixed supply of houses, and could perhaps be eliminated if houses were not in fixed supply.

Figure A.5: Price Boom After Domestic Liberalization When $m > 1/2$

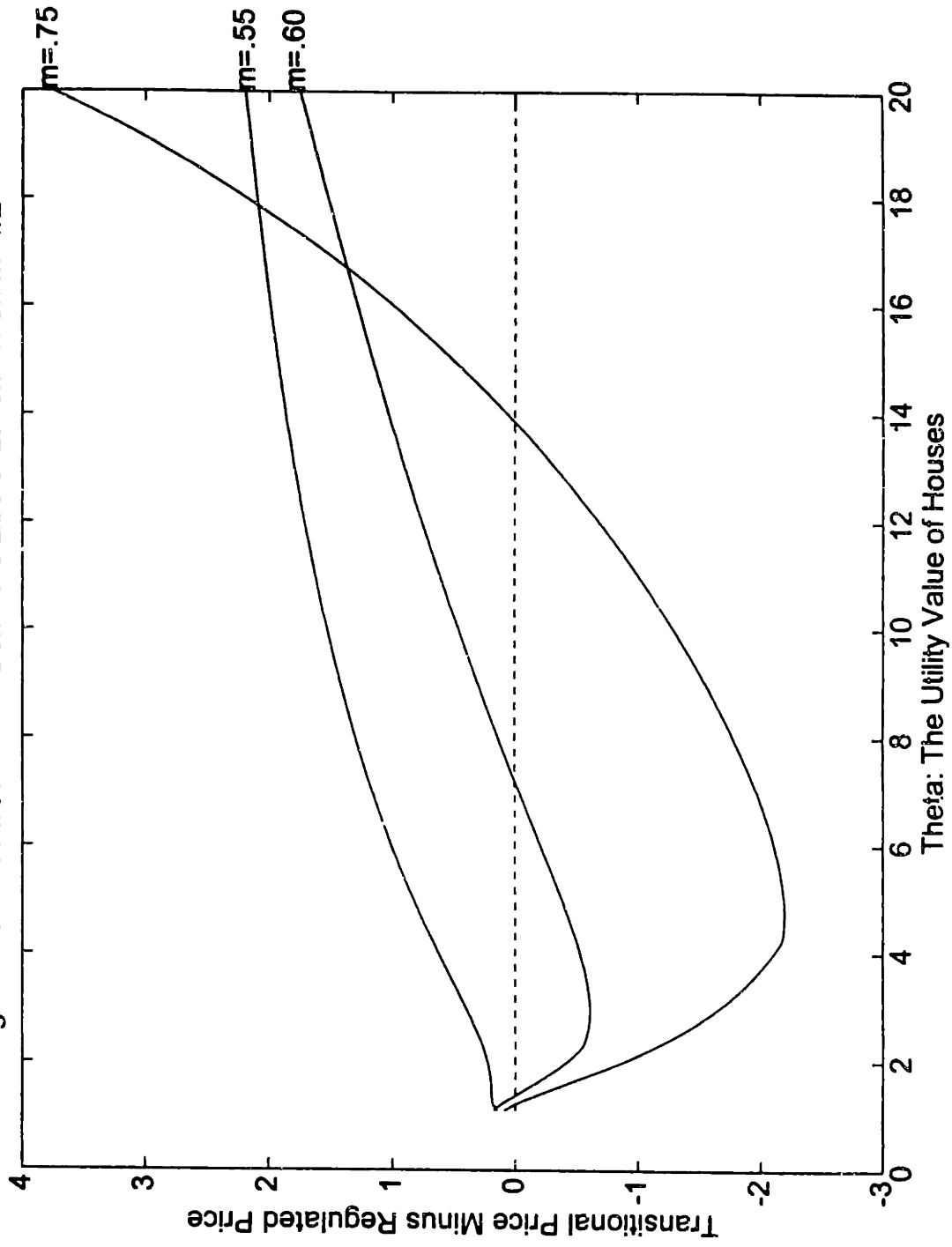
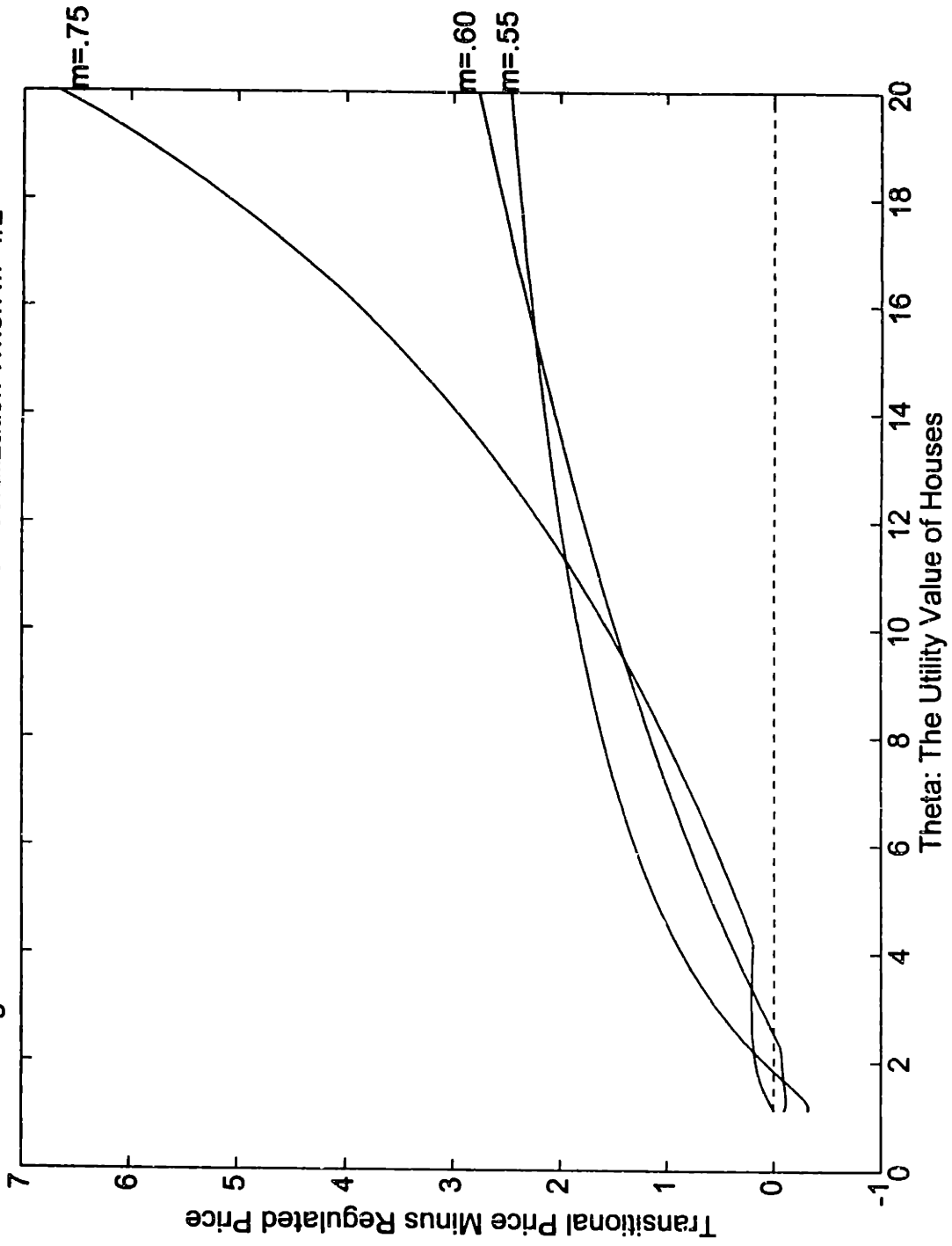


Figure A.6: Price Bust After Domestic Liberalization When $m > 1/2$



CHAPTER 2: LABOR MARKET POOLING AND REAL WAGES

I. INTRODUCTION

Marshall listed the availability of specialized labor among the motives for economic agglomeration. One variant of this labor market pooling story is that labor markets with less risk of unemployment or lower variability of wages are attractive to workers. Firms can create such markets by locating near other firms which face imperfectly correlated labor demand shocks. As a result, firms which agglomerate by locating in such pooled markets will enjoy lower wages. In this paper, I test the premise of this argument; namely that workers value markets in which labor demand shocks are less correlated across firms.

The argument that pooled labor markets can be attractive to workers is only one part of the labor market motive for agglomeration. Krugman (1991a) has demonstrated that firms may benefit from locating near other firms with imperfectly correlated shocks even in the absence of risk aversion on the part of workers. In pooled markets, a firm's boom times (periods of positive demand shocks) are not likely to be boom times for other local firms, so needed labor is likely to be available at attractive wages. Still, despite benefits available to firms from pooling, the labor market motive for agglomeration has traditionally been associated with the notion that workers value pooled markets, and the impetus for agglomeration would be limited if only firms, and not workers, benefitted from labor market pooling.

To date, tests of the labor market pooling hypothesis have focused on the geographic concentration of employment or geographic differences in unemployment. Miracky (1995), for

example, applies the logic of pooling by firms to pooling by industries, and finds evidence that pairs of industries are more likely to locate together when their shocks are less correlated over time. This result is implied by the labor market pooling hypothesis.¹ Neumann and Topel (1991) examine the relationship between unemployment rates in U.S. states and the local covariance matrix of labor demand shocks across industries.² By contrast, I focus on the relationship between wages and the local correlation of labor demand shocks.

Abowd and Ashenfelter (1981) have examined wage premia across sectors in the context of a model in which hours worked may be constrained. They use microdata data to generate a prediction on the individual probability of layoff and individual layoff duration, then estimate a wage premium model at the industry level. Their results seem to support a risk premium model of wage differentials. Abowd and Ashenfelter analyze wage differentials across industries and do not include location risk parameters, such as the covariance of employment shocks across industries within a city. Nevertheless, their results suggest that labor market pooling might be relevant to wage differentials across locations.

In this paper, I use wage data from the Current Population Survey and employment data from USA Counties and County Business Patterns to explore whether labor market pooling has any effect on real wage differentials across U.S. cities. In other words, I ask whether workers value pooling. I present two models of worker location. In the first, workers choose locations

¹Miracky finds this result at the two-digit SIC level of aggregation, but not at the three-digit level. He suggests that externalities may dominate location patterns at the more disaggregated level.

²Neumann and Topel construct the covariance matrix of industry shocks at the national level, then weight the matrix with local (state) industry shares. I will use industry shocks at the local (city) level to construct separate covariance matrices for each city in my analysis.

before they have jobs, then face location-specific shocks. As a result, they consider the expected employment rate and the variance of the real wage (which I relate to the variance of the employment rate) when making a location choice. In the second model, workers chose jobs and locations simultaneously, then face shocks in their chosen locations. After shocks are realized, workers may lose their original jobs and be forced to look for new ones in the same location. As a result, covariances between shocks to local industries become relevant in evaluating jobs.

The evidence for worker's valuation of labor market pooling is mixed. Regression estimates of the first model show a significant and positive relationship between the variance of the employment rate and the real wage premium. Instrumental variable results imply that a one-standard deviation increase in the variance of the unemployment rate is associated with a 7 percentage point increase in the real wage.³ Since one typically associates variance with risk, this evidence seems to support the notion that pooling is valuable to workers because they are risk-averse. On the other hand, contrary to the prediction of a compensating differentials model, increases in the mean probability of employment are also positively associated with the real wage premium. Since there is not a clear theoretical prediction about the relationship between labor market pooling and the mean employment rate, this result remains a puzzle for purposes of the current study.

The evidence does not offer much support for the second model, which generates a prediction about within-city differences in wages. For industry-city pairs with a relatively large

³The mean and variance of the employment rate appear on the RHS of the regression. Since measured labor force participation varies in a manner that presumably has little to do with the true probability of finding a job, the moments of the employment rate are likely to be mismeasured. I instrument for these moments using the moments of the ratio of employment to population.

number of individual observations (50 or more) in my sample, the variable that captures labor market pooling for an industry-city pair (the share-weighted sum of covariances of shocks to all industries in the location) has a significant relationship with the expected sign.⁴ For the full sample of industry-city pairs, however, the model does not fit well. The coefficient on the labor market pooling variable is insignificant and has the wrong sign. A preliminary exploration of this result has uncovered a relationship between industry share of local employment and within-city wage differentials. For the full sample of industry-city pairs, industry share dominates all other variables as a positive predictor of the within-city wage differential. The latter result may imply a scale effect, but such an effect could only be sustained by limited intersectoral mobility of labor within cities. Although the possibility of a scale effect is intriguing, it is outside the scope of this paper.

The remainder of the paper proceeds as follows. Section 2 reviews the relationship between pooled labor markets, agglomeration, and real wages. Sections 3 and 4 present separate models of worker location and evidence for each. Section 5 concludes. An appendix provides some details about construction of the data set.

II. LABOR MARKET POOLING AND REAL WAGES

Consider the simplest Krugman (1991a) formulation of the labor market pooling story. Two equally-sized firms decide where to locate. The firms face perfectly negatively correlated labor demand shocks. By assumption, there is a fixed supply of total workers, with identical

⁴The effect in this case is implausibly large, however. The point estimate implies that an increase of one (cross-sectional) standard deviation in the labor market pooling variable (which means a decrease the degree of pooling) would be associated with a 41 percentage point increase in the relative within-city wage.

labor supply schedules, who will locate wherever is most advantageous. Workers cannot migrate in response to current-period labor demand shocks, however. If the firms choose separate locations, two markets will arise, with half of the workers in each. On average, wages and employment in these markets will look the same, but the local experiences will differ period by period. Consider the extreme cases. If labor markets clear, then wages will vary in both markets according to the labor demand shocks. If wages are fixed, then unemployment will vary in each market according to labor demand shocks. By contrast, if both firms and all workers locate in the same market, the wage and employment will be constant. If labor markets clear, then the wage in this case will equal the average wage in the case where separate markets arise.

If wages are fixed, so there is unemployment, then agglomeration benefits each firm because there will be workers available during good times (since these will be bad times for the other firm). If wages are flexible, then local wages will be higher during bad times for each firm if the firms agglomerate, but lower during good times. The latter effect tends to dominate expected profits because firms hire more workers during good times than during bad.

So far, nothing has been said about worker preferences. As Krugman points out, if workers care only about expected wages, this story for pooling carries through on the basis of the incentives facing firms. If workers are to any extent risk-averse, however, they too prefer pooled markets. If our two firms locate together, workers face less variable employment and wages than if the firms disperse, but the same average wages and average employment. Risk-aversion would create a preference for the pooled market.

More generally, the location decision facing firms is not dichotomous. In practice, the U.S. is characterized by the existence of a number of agglomerated centers--cities--which persist

over time. If workers are free to choose locations, then expected wage differentials across locations should equalize expected utility of workers across locations. In particular, after controlling for amenity differences across locations, and assuming that migration is costly, workers who locate in less pooled markets should require higher real wages as compensation. This is the proposition I test in the remainder of the paper.

Although agglomeration from pooling does not require risk-aversion by workers, there is reason to believe that the impetus for agglomeration will be limited if only firms, and not workers, have an incentive to pool. Think of agglomeration as a process by which initially dispersed firms gather into concentrated centers. At each stage of the process, a firm considering relocation will find it more valuable to move to a pooled location if it can pay lower wages there. Moreover, congestion costs may tend to increase local nominal wages as markets increase in size. Suppose that local land, which is an element of worker consumption, is fixed. If workers are risk-neutral, they will equalize expected real wages across locations over time. As a local center becomes more congested, local land prices will increase, and firms will be forced to pay higher average nominal wages in the agglomerated location. This will limit the value of pooling. If workers also value pooled markets, however, they will accept lower real wages there, and thus more agglomeration can be supported.

Finally, the stylized example above was constructed so that the mean employment rate was the same in the pooled and unpooled markets. It is standard to consider an increase in risk as a mean-preserving spread. In practice, however, the mean employment rate might also be affected by the degree of pooling. The mean employment rate will have an effect on wage differentials even for risk-neutral workers, since expected compensation in a location will depend

on the chance of landing a job there. *A priori*, the sign of the relationship between the mean employment rate and the degree of pooling is not clear. It seems plausible, for example, that markets with a high degree of pooling could have lower real wages and a lower employment rate in equilibrium, since such markets will be attractive to workers. This is a labor supply effect. The smaller variance of employment in pooled markets could compensate for a lower mean employment rate if workers are risk-averse.

On the other hand, Neumann and Topel (1991) present a model with risk-neutral workers and show that more pooled markets have lower unemployment rates. One reason for this result is that more pooled markets operate more efficiently. Since workers are risk-neutral, the market outcome maximizes the expected joint surplus of workers and firms in each location. Markets that are more pooled require a smaller labor force. Thus, in the Neumann-Topel framework, pooling would not be associated with smaller markets, not larger, in contrast to the pooling hypothesis about agglomeration. Matters are less clear when workers are risk-averse, however, as the authors note. Neumann and Topel's empirical work provides mixed evidence for the relationship between pooling and the mean employment rate. They obtain variances and covariances of industry shocks using U.S. data, then weight these by state industry shares to construct a measure of local labor market pooling. In a regression model with state fixed effects, the pooling variable typically does not have a significant relationship with the state unemployment rate, although the interaction of other variables with the pooling variable are significant. The pooling variable is significant in the model without state fixed effects.⁵

⁵Neumann and Topel are investigating other relationships in addition to the mean effect of pooling on unemployment rates. The interaction terms are supportive of some of the predictions of their model.

3. POOLING AND REAL WAGE PREMIA I: THEORY AND EVIDENCE

The informal analysis of Section 2 suggests that pooled labor markets might be attractive to workers because they reduce the variance of the employment rate and the real wage. Thus, one might expect that the difference in wages across locations would be related to these variables.

In this section, I consider the wage premium demanded by workers in a given location under the assumption that workers choose locations before they have jobs and before shocks are realized. I assume that workers cannot relocate quickly enough to avoid shocks in their chosen locations. As a result, workers will consider both the (expected) probability of employment and the variance of the real wage in the location decision. In equilibrium, workers will distribute themselves such that the expected wage premium for each location reflects local values of these two variables. I make assumptions to relate the variance of the real wage to the variance of the employment rate. In the empirical part of this section, I present evidence that supports the prediction of the model with respect to the variance, but not with respect to the mean. .

3.1 THEORY

Consider the location decision for a representative worker. There are a set of locations, c (for city), each offering a probability \tilde{e}_c of employment at real wage $\tilde{\omega}_c$. Call the means of these variables \bar{e}_c and $\bar{\omega}_c$. Assume that the worker must make the location decision before receiving a job offer and that unemployed workers receive the same real compensation $\underline{\omega}$ in all locations. The location variables \tilde{e}_c and $\tilde{\omega}_c$ are random variables whose realization depends on location-specific labor demand shocks. The means and variances of the employment

probabilities and the real wages are known, as is the covariance of these two variables. For convenience, assume that $c=1$ is the reference location, which offers a known probability of employment e_1 at known real wage ω_1 . In practice, the reference location will be a hypothetical construct, with employment probability and real wage equal to the cross-sectional means of \bar{e}_c and $\bar{\omega}_c$. If workers have utility functions of the form $u(\tilde{\omega}_c)+a_c$, where a_c is the value of amenities in location c , then an equilibrium distribution of workers will require that each worker equates expected utility across locations:

$$E[\bar{e}_c u(\tilde{\omega}_c) + (1 - \bar{e}_c) u(\underline{\omega})] + a_c = e_1 u(\omega_1) + (1 - e_1) u(\underline{\omega}) \quad (1)$$

where the reference location is assumed to have a zero value of amenities, and the expectation is taken over \tilde{e} and $\tilde{\omega}$ for each location.

One could proceed here by taking a second-order Taylor approximation of (1) around $\tilde{e}_c = e_1$ and $\tilde{\omega}_c = \bar{\omega}_1$, then solving for the expected wage premium $(\bar{\omega}_c - \bar{\omega}_1)$. This would yield a solution for the expected wage premium in terms of the mean employment rate, the variance of the real wage, and the covariance of the employment rate and the real wage.⁶ An alternative approach is to make sufficient assumptions about the relationship between local wages and local employment to allow the wage premium to be written in terms of the moments of the employment rate. I choose the latter approach for two reasons. First, the local employment rate and the real wage presumably respond jointly to the same set of local shocks. In the spirit of the pooling hypothesis, I take these shocks to be labor demand shocks. Second, in the empirical work, I will estimate the local wage premium from microdata on individual workers. As a result,

⁶Since expected utility is linear in the employment rate, the variance of the employment rate would not enter into the risk premium, unless it were related to the variance of the real wage.

the wage premium series has sampling variance in addition to its true variance over time. Using this series to construct a wage variance over time would produce a badly mismeasured variable and perhaps a biased one, since locations with fewer individual observations in the sample would tend to have larger sampling variances and thus might have larger variances of wages over time. Although there are ways to handle these problems, linking the wage premium to the moments of the employment rate makes for more straightforward econometrics.

To relate the wage premium to the moments of the employment rate, I will assume that in each city, movements of the real wage around the mean real wage are related to movements of the employment rate around the mean employment rate. Specifically, let $\tilde{g}_c \equiv \tilde{e}_c - \bar{e}_c$ and $\tilde{h}_c \equiv \tilde{\omega}_c - \bar{\omega}_c$. I assume that $\tilde{h}_c \equiv h\tilde{g}_c$ and $h(0)=0$. My prior is that $h' > 0$, *i.e.*, that the real wage is procyclical in each location, and that $h'' < 0$. In order for the wage premium to be comparable across locations, I need to assume that the function h and its first two derivatives have the same value in each location, when evaluated around the mean employment rate for each location. The function need not behave identically across cities when evaluated away from the approximation point. Finally, let $\pi_c \equiv \bar{\omega}_c - \omega_1$ and $\Delta_c \equiv \bar{e}_c - e_1$. The variable π_c is the expected wage premium for location c and the variable Δ_c is the difference in mean employment rates between location c and the reference location. Using these definitions and assumptions, equation (1) can be rewritten as follows:

$$E[(\tilde{g}_c + \Delta_c + e_1)u(h(\tilde{g}_c) + \pi_c + \omega_1) - (1 - \tilde{g}_c - \Delta_c - e_1)u(\underline{\omega})] + a_c = e_1 u(\omega_1) + (1 - e_1)u(\underline{\omega}) \quad (2)$$

Now take a second-order Taylor approximation around $\tilde{g}_c = 0$ and a first-order approximation around $\pi_c = 0$ and $\Delta_c = 0$. I will assume that the expected wage premium π_c and the difference in mean employment rates Δ_c , which are known, are small enough that their second-order terms can be ignored. Taking the approximation yields

$$\begin{aligned}
& e_1 u(\omega_1) + (1 - e_1) u(\underline{\omega}) + a_c + e_1 u'(\omega_1) \pi_c + u(\omega_1) \Delta_c + [u(\omega_1) - u(\underline{\omega}) + e_1 u'(\omega_1) h'(0)] E(\tilde{g}_c) \\
& + \frac{1}{2} (2u'(\omega_1) h'(0) + e_1 [u''(\omega_1) (h'(0))^2 + u'(\omega_1) h''(0)]) E(\tilde{g}_c)^2 = e_1 u(\omega_1) + (1 - e_1) u(\underline{\omega}) \quad (3)
\end{aligned}$$

Solving for π_c , noting that $E\tilde{g}=0$, and writing $E\tilde{g}^2$ (the variance of the local employment rate) as σ^2 gives

$$\pi = -\frac{a}{e_1 u'(\omega_1)} - \frac{u(\omega_1)}{e_1 u'(\omega_1)} \Delta_c + \frac{\sigma^2}{h'(0)} \left(-\frac{1}{e_1} - \frac{u''(\omega_1) (h'(0))^2 + u'(\omega_1) h''(0)}{2u'(\omega_1) h'(0)} \right) \quad (4)$$

where the location subscripts have been dropped on π , a , and σ^2 .

By equation (4), the premium associated with choosing a location has three components: amenities, the mean probability of finding employment, and the variance in that probability, which relates to the variance of the real wage. The first term on the RHS of (4) relates to the value of amenities. Positive amenities ($a_c > 0$) reduce the expected premium required for a location. The second term on the RHS of (4) involves the difference between the mean probability of finding employment in the location and the mean probability in the reference location. An increase in the probability of finding a job makes a location more attractive and reduces the required premium, other things equal. Finally, the sign on the variance of the probability of employment is ambiguous. The sign is determined by the last expression in parentheses in (4). This expression consists of a negative constant plus a term that relates to the curvature of the utility function and the h function. Under my assumptions about the h function, the latter term is positive. The nonconstant term is similar to an absolute risk-aversion term (think of the primitive function as uh). The function h enters because fluctuations in

employment rates do not enter utility directly, but only through the real wage. If the risk-aversion effect is strong enough, then increasing the variance will increase the wage premium. The constant term enters because variance is valuable when the mean is low (since there is little downside risk). If the mean rate of employment in the reference location (which I have assumed to be close to the mean rate in the other locations) is low enough, than an increase in the variance will reduce the wage premium.

3.2 AN EMPIRICAL FRAMEWORK

From equation (4), one can derive a basic estimating equation to evaluate the value of labor market pooling from the point of view of workers. Divide (4) by ω_1 to obtain an expected percentage wage premium for location c . Call this premium π_c . Let A_c be a column vector of amenity values (over the set of all amenities) for location c . Then define a constant k , a vector of coefficients Γ , and a set of coefficients β_i to rewrite (4) (after dividing by ω_1) as follows:

$$\bar{\pi}_c = \kappa + A'_c \Lambda_1 + \delta_1 \bar{e}_c + \delta_2 \sigma^2_c \quad (5)$$

To build an empirical counterpart to (5), begin with cross-sectional of microdata on individual workers and consider the following model:

$$\ln(w_{kc}) = X'_k \delta + \Pi_c + \epsilon_{kc} \quad (6)$$

$$\pi_c \equiv \Pi_c - P_c = \bar{\pi}_c + v_c \quad (7)$$

where w is the nominal wage, X is a vector of individual characteristics (including demographic variables and occupation and industry dummies), and k refers to individuals and c to locations.

Π_c is the percentage nominal wage premium for location c and P_c is an adjustment for relative price levels.

The empirical strategy is to estimate (6), collect the location nominal wage premia (Π), adjust these premia for relative prices to construct $\hat{\pi}$, then estimate (7), substituting the expression for the expected real wage premium in (5). One might wish to use (7) to substitute for Π in (6), and then estimate (6) in one step. The literature on interindustry wage differentials implies that the two-step procedure is warranted. Within the context of that literature, it has been noted (Moulton (1986), Dickens and Katz (1987)) that the presence of unobserved industry fixed effects will bias the standard errors in the one-step procedure. The two-step procedure corrects for this. Analogously, in my problem, a two-step procedure is warranted if there are unobserved city effects. Of course, I must assume that any such unobserved effects are not strongly correlated with the regressors in the second step.

3.3 DATA AND METHODOLOGY

My source for microdata on wages and worker characteristics is the Current Population Survey annual earnings file for the years 1986-1993. I limit the analysis to manufacturing workers. As part of ongoing research on related project, I have built a data set of annual observations on population, employment, and employment by SIC sector for 34 cities, chosen to match the CPS over a longer time period than the sample used in this paper. The original data are at the county level. I aggregate into cities using consistent county definitions. The city definitions I use are based on the 1979 SMSA definitions, with some adjustments (described in the Appendix). City definitions have expanded over time, and the CPS sample I use is based on

the 1983 CMSA/PMSA definitions. With careful attention to county definitions, however, and making use of CPS PMSA designations for large cities, it is possible to construct a CPS sample that matches my city definitions quite closely. The sample cities and their county definitions are listed in the Appendix.⁷ The population and employment data span 1977-1995 and come from USA Counties 1986 (cd-rom).⁸ The source for employment by sector is County Business Patterns. I have constructed the sectoral data for the years 1986-1994. The sectoral data will be used in the Section 4.

The CPS lists nominal wages. To convert into location real wages, my primary source is the Chamber of Commerce cross-sectional city cost-of-living index. The Chamber of Commerce index is based on a comparison of goods prices across cities at a point in time. The consumption basket is intended to be representative of the lifestyle of “mid-management executive household.” The index is normalized to equal 100 at the mean cost-of-living in the city sample. In addition to sampling concerns and choice of consumption basket, a problem with the index is the lack of consistency in the set of cities included. Some cities appear sporadically. As a result, I can only obtain price observations for a subset of my 34 cities, ranging between 23 and 29 over the years of my sample. Moreover, the city indexes do not match the Census SMSA city definitions. Instead, prices are reported at the MSA level, which is appropriate for small cities, but problematic for larger ones, since multiple MSA price levels will be reported within the same

⁷The final city definition encompasses a somewhat smaller area for larger metropolitan areas than the modern CMSA definition. For example, unlike the modern definition of the New York SMSA, my definition does not include the Connecticut suburbs.

⁸The USA Counties 1996 cd-rom is missing observations for employment and population for 1987. Possibly this represents some change in variable definition. Since I consider rates rather than absolute levels, I simply treat 1987 as a missing observation.

city.⁹ I use the price index for the central city of my city definition in all cases.¹⁰ Finally, the index is produced quarterly; I use the third quarter observation for each year. Despite the problems with the Chamber of Commerce Index, it is the only cross-sectional price index for cities readily available.

Recently (Kokowski, Cardiff, and Moulton (1994)) staff members at the Bureau of Labor Statistics have made an attempt to construct a cross-city cost of living index using BLS data. The methodology is based on hedonic analysis of goods prices across locations and uses data from July 1988 to June 1989. The results are preliminary, unofficial, and only available for 30 cities (only 27 of which are in my sample). Separate cross-city indexes are created for several categories of consumption expenditure. William Wheaton at M.I.T. has constructed aggregate city indices from these component indices using aggregate consumption weights. Professor Wheaton has kindly made these price data available to me. The new price indexes allow me to construct an alternative measure of the real wage, at least for 1988 and 1989, for use in the second-stage regressions. This provides some check on the results using the Chamber of Commerce price index.

Finally, I need data on city amenities. I have no theoretical foundation to choose such data, so I use variables which are easily obtainable. I obtain 3 climate variables--minimum January temperature, maximum July temperature, and annual precipitation--and 4 "quality of life

⁹This problem is mitigated somewhat by the fact that I use city definitions based more closely on 1979 SMSA definitions than 1983 CMSA definitions. As I noted earlier, the definitions encompass a smaller geographic scope for the larger metropolitan areas than the modern CMSA definitions.

¹⁰If all of the MSAs which compose an SMSA were included in each quarter of data, I could perhaps weight the individual MSA observations by relative population to construct an SMSA index. In fact, however, only some of the MSAs that compose an SMSA are included in any given quarter, and the set of MSAs changes.

variables"--percentage of college graduates in the over 25 population, number of hospital beds per 100,000 population, crimes per 100,000 population, and average commuting time in minutes. I use the City and County Data Book 1994 (online at the University of Virginia) as a source. I take the percentage of college graduates variable as a broad proxy for local amenities (e.g., support for the arts) that education and wealth might provide. The climate variables are 30-year averages over 1961-90. The data on college graduates and commuting time are from 1990; the data on hospital beds and crime are from 1991. All variables are measured in the central MSA of each of my cities. One could argue indefinitely about the choice of city amenities. My objective is not to estimate the value of amenities, but rather to control for them sufficiently to obtain estimates of the risk parameters of the wage premium.

Before proceeding, I must construct a probability of employment from my raw data. One possibility is to use the measured employment rate. In principle, the employment rate seems the proper variable. In practice, however, the measured employment rate is affected by movements in measured labor force participation which may have little to do with the true probability of finding a job. For example, if workers drop out of the official labor market when bad shocks are realized in a location, the mean employment rate may be overstated and the variance of the employment rate may be understated. An alternative measure of the probability of finding a job is the ratio of employment to population. Although this measure has its drawbacks, it seems reasonable to assume that the state of local demand has less influence over movements in population than movements in participation, so population might be a better scaling variable. Finally, a third approach is to use the moments of the ratio of employment to population as instruments for the moments of the employment rate, under the assumption that the

latter variables are mismeasured, perhaps in a biased way. Assuming that the a true measure of employment to labor force is the proper theoretical variable, the instrumental variables approach is the proper estimation procedure. I present evidence from all three approaches below.

I calculate the variance of the probability of employment as the variance of the residuals of a regression of the employment probability (measured either as employment divided by the labor force or employment divided by population) on a time trend and a constant. From the regression results I generate a predicted probability of employment (using both measures) for 1989, and use this variable as the predicted probability of employment. I do not use the annual prediction for each year, because, by construction, the annual prediction will be trending. Presumably these trends have little to do with cross sectional risk considerations.

I limit my CPS sample to the 34 cities for which I have employment data. For each year of the CPS sample, I regress the log of hourly wages on city dummies, experience, experience squared, quarterly time dummies, and dummies indicating industry, occupation, gender, marital status, union status, full-time status, race (white vs. nonwhite), and university status¹¹. I group industries into categories to match my SIC employment breakdowns by city (described in Section 4). Since the CPS uses Census (CIC) categories to group employment, I must build a correspondence between SIC and CIC categories. Essentially, the final categories I use are at the 3-digit CIC level of aggregation, although a few CIC categories are dropped because they cannot be identified with an SIC code (see section 4.3 below). I group occupations into eight broad categories. After running the first stage regressions, I obtain the city dummies, and adjust them

¹¹For 1986-1991, I consider university education to be equivalent to the completion of 16 or more years of education. The CPS schooling variable changes in 1992 to indicate whether each individual has received a college degree.

for relative prices using the Chamber of Commerce index and the BLS-derived price series. Since the BLS price series is only available for 1988-89, I apply the BLS price series to wage premia only in these two years. I use the real wage premia as the LHS variable for the second stage regressions. For the RHS variables, I use the calculated mean and variance of the employment probability and the amenity variables. For the regressions using the Chamber of Commerce prices, I also include year dummies, to normalize real wages around the sample mean in each period. For the regressions using BLS prices, I constrain the mean real wage to be equal in 1988 and 1989.

3.4 RESULTS

Table 1 presents the mean estimated nominal city wage premia, as well as the nominal and real wage premia for 1989 constructed under alternative price indices. The hypothesis that that nominal wages are equal across cities (after controlling for human capital, industry, and occupation) is easily rejected at the 1% level by F-tests for each year of the first stage regressions. The nominal wage premia in Table 1 are normalized to mean zero over the sample, as are the wage premia. Since there are missing observations on prices and the sample differs over the two price indices--Chamber of Commerce and BLS-derived--the real wage premia under these alternative measures are not strictly comparable. The missing observations for New York and Boston in the 1989 Chamber of Commerce index probably make real wages under the alternative price indices look more similar than is in fact the case. New York and Boston indices tend to be much higher (in relative terms) in other years of the Chamber of Commerce sample than in the 1989 BLS-derived sample. The actual price indices presented in Table 1 have not

Table 1: Manufacturing Wage Premia Across Cities

1989 Nominal and Real Premia are normalized to mean zero over the sample. Since the samples differ over the two price indices, the real premia in the last two columns are not strictly comparable. The actual price indexes have not been normalized to zero over the sample. Each index is set to 100 at the mean of its full sample of cities.

City	Average Nominal Premium (1986- 1993)	1989 Nominal Premium	1989 Chamber of Commerce Price Index	1989 BLS- derived Price Index	1989 Real Premium, Ch. of Com. Prices	1989 Real Premium, BLS- derived Prices
Albany, NY	-4.1%	-5.4%	107.9	-----	-2.8%	-----
Atlanta, GA	-0.5%	3.0%	107.1	108.5	6.4%	0.7%
Baltimore, MD	2.2%	-0.2%	-----	104.7	-----	1.1%
Birmingham, AL	-13.0%	-15.3%	98.5	-----	-3.6%	-----
Boston, MA	5.2%	6.3%	-----	127.7	-----	-12.3%
Buffalo, NY	-4.9%	-7.3%	107.2	99	-4.0%	-0.4%
Chicago, IL	-1.0%	-1.7%	-----	114.2	-----	-9.0%
Cincinnati, OH	0.3%	2.7%	-----	101.6	-----	7.0%
Cleveland, OH	-3.1%	-5.0%	109.5	98.1	-3.8%	2.9%
Columbus, OH	-2.1%	-7.4%	102.4	-----	0.4%	-----
Dallas, TX	-3.8%	-5.8%	103.8	95.2	0.7%	5.0%
Denver, CO	-2.9%	0.2%	101.5	96.6	8.9%	9.5%
Detroit, MI	6.8%	5.0%	-----	98.4	-----	12.6%
Greensboro, NC	-0.6%	-1.3%	97.5	-----	11.4%	-----
Houston, TX	-3.1%	-2.4%	101.9	98.8	5.9%	4.7%
Indianapolis, IN	-1.0%	-3.6%	99.3	-----	7.3%	-----
Kansas City, MO	-3.5%	-9.0%	95.1	92.2	6.2%	5.0%

been normalized to mean zero over my sample. These have been constructed to mean 100 over the full Chamber of Commerce and BLS samples.

One point to note from Table 1 is that adjusting for relative prices does not eliminate wage differentials across cities. Real wage differentials are of similar magnitude to nominal ones, but the ranking of cities differs.

Table 2 presents second-stage regressions using the Chamber of Commerce prices to construct real wages. Table 3 presents results using the BLS-derived price indices for the years 1988 and 1989. The first two columns in each table offer results based on the definition of the probability of employment as the ratio of employment to population. The second two columns use the ratio of employment to the labor force as the definition of the probability of employment. The final column uses the moments of the population-scaled employment rate as instruments for the moments of the labor force-scaled employment rate. The OLS results in each table are given for two specifications-- with and without amenities included. For brevity, the instrumental variable results are presented only under the amenities specification. Considering Table 2, which uses the Chamber of Commerce price index for all years, the OLS regressions without amenities produce positive and significant estimates of the effect of the the mean probability of employment on real wage premia under both definitions of the probability of employment. The variance has an insignificant effect under the population-based employment rate definition, and a positive and significant effect under the labor-force based definition. Once amenities are added to the specification, the mean and the variance have positive and significant effects under the population-based definition; neither have significant effects under the labor-force based definition. Finally, using the moments of the population-based definition as instruments for the

Table 2: City Real Wage Premia (Chamber of Commerce Prices) and Employment Risk

The last column uses the moments of the employment-population ratio as instruments for the moments of the employment-labor force ratio. All specifications include year dummies.

	OLS/ Huber s.e	OLS/ Huber s.e	OLS/ Huber s.e	OLS/ Huber s.e.	IV
Mean emp./pop	1.311	0.850	-----	-----	-----
	(0.249)	(0.351)			
Var. of emp./pop.	-81.636	173.556	-----	-----	-----
	(93.251)	(85.070)			
Mean emp./LF	-----	-----	5.987	47.837	8.074
			(1.083)	(55.937)	(2.886)
Var. of emp./LF	-----	-----	203.973	-0.440	422.438
			(52.458)	(1.240)	(196.964)
Jan. min. temp. (x100)	-----	-0.297	-----	-0.463	-0.133
		(0.102)		(0.101)	(0.161)
Jul. max. temp. (x100)	-----	0.300	-----	0.374	0.470
		(0.113)		(0.122)	(0.167)
Precipitation (x100)	-----	0.224	-----	0.192	0.087
		(0.056)		(0.054)	(0.093)
% College Grad. (x100)	-----	-0.179	-----	0.147	-0.113
		(0.140)		(0.122)	(0.203)
Hosp. Beds/100K (x100)	-----	-0.005	-----	-0.009	-0.006
		(0.002)		(0.002)	(0.004)
Crimes/100K (x100)	-----	7.13e-04	-----	0.001	0.001
		(3.19e-04)		(2.96e-04)	(5.78e-04)
Commuting time (x100)	-----	-1.961	-----	-1.976	-1.413
		(0.316)		(0.337)	(0.306)
Observations	205	205	205	205	205
R ²	.152	.552	.169	.526	.386

Table 3: City Real Wage Premia (BLS-Derived Prices) and Employment Risk

The last column uses the moments of the employment-population ratio as instruments for the moments of the employment-labor force ratio. All specifications include a constant term.

	OLS/ Huber s.e.	OLS/ Huber s.e.	OLS/ Huber s.e.	OLS/ Huber s.e.	IV
Mean emp./pop	0.812	1.038	-----	-----	-----
	(0.274)	(0.334)			
Var. of emp./pop.	-133.539	11.939	-----	-----	-----
	(140.989)	(132.427)			
Mean emp./LF	-----	-----	5.541	2.788	13.786
			(1.140)	(1.582)	(10.887)
Var. of emp./LF	-----	-----	307.568	157.993	511.371
			(84.627)	(84.410)	(680.511)
Jan. min. temp. (x100)	-----	-0.244	-----	-0.291	0.127
		(0.097)		(0.088)	(0.421)
Jul. max. temp. (x100)	-----	0.120	-----	0.257	0.214
		(0.173)		(0.214)	(0.389)
Precipitation (x100)	-----	0.109	-----	0.082	0.130
		(0.093)		(0.106)	(0.144)
% College Grad. (x100)	-----	-0.435	-----	-0.163	-0.796
		(0.164)		(0.135)	(0.393)
Hosp. Beds/100K (x100)	-----	-0.005	-----	-0.006	-0.004
		(0.003)		(0.002)	(0.004)
Crimes/100K (x100)	-----	6.10e-05	-----	5.02e-04	1.32e-04
		(3.29e-04)		(2.27e-04)	(5.28e-04)
Commuting time (x100)	-----	-1.195	-----	-0.975	-0.331
		(0.222)		(0.272)	(0.943)
Observations	54	54	54	54	54
R ²	.129	.667	.225	.628	.267

moments of the labor force-based definition produces positive and significant coefficient estimates for both moments of the employment rate. Under the assumption that a properly-measured labor force definition of the employment rate is the theoretical variable of interest, instrumental variables is the proper approach.

The positive sign on the variance under the instrumental variables approach is consistent with the model presented above and supports the notion that risk-averse workers value pooled labor markets. The coefficient estimate on the variance under the IV approach implies that an increase in the variance of the employment rate by one (cross sectional) standard deviation would be associated with a 7.2 percentage point increase in the real wage premium. The positive sign on the mean employment rate, however, is inconsistent with the compensating differential framework. Increases in the mean employment rate should make a location more attractive and thus reduce the required location real wage premium. I have noted above the lack of a clear theoretical relationship between the mean and the variance under the labor market pooling hypothesis. As a result, the positive effect of the mean must remain a puzzle for purposes of the current paper.

The coefficients on the city amenities are typically not significant individually. Those that are seem reasonable, except for the negative coefficient on commuting in the OLS regressions. The negative sign implies that an increase in commuting time reduces the wage premium required for a location, which seems perverse. There are undoubtedly omitted amenities. Perhaps commuting time is correlated with one of these in a way that is not obvious.

Finally, Table 3 provides a check on these results by constructing real wage premia under the BLS-derived price index. Since this index is based on data from 1988-1989, I limit the

sample to these two years. I apply the single BLS-derived price index to nominal wage premia estimated for 1988 and 1989 to construct real wage premia for each of these years. Then I run the same regressions as presented in Table 2. I have a much smaller sample available with the BLS price index, so the estimation produces less significant results. In the OLS regressions with amenities, the point estimates on both moments of the probability of employment (under the population and labor force definitions) are positive, but only significant (at the 10% level) under the labor force definition. The instrumental variable results produce point estimates reasonably similar to the earlier IV estimates, although not significant in this case. It is not surprising that I lose significance with only 54 observations. I take the similarity of the point estimates as weak confirmation of the basic results in Table 2. Lacking more and better data on city prices, little more can be said at present.

In sum, there is some evidence that increases in the variance of the probability of employment have positive effects on real wage premia. This evidence is consistent with the idea that risk-averse workers value pooled markets. On the other hand, increases in the mean are also associated with increases in premia, a result inconsistent with a compensating differential framework. Empirical work on real wage premia is hindered by two problems: the lack of an accepted cross-sectional city price index and the lack of clear guidance on the set of amenities that should be included as regressors. In the next section, I construct an alternative model of worker location in which workers receive job offers before they choose locations. This model generates a prediction about the relationship between pooling and within-city differences in nominal wages. As a result, it avoids issues relating to price indices and city amenities and offers a cleaner test of the pooling hypothesis.

III. LABOR MARKET POOLING AND WAGE PREMIA II: THEORY AND EVIDENCE

In the previous section, I examined the mean wage premia across cities under the assumption that a worker chose a city before conducting a job search. In this section, I consider an alternative model, in which workers choose a job and a city simultaneously. I show that the industry wage premium in each location can be written as a function of the mean city premium, the variance of employment shocks in the worker's industry, the covariances between these shocks and shocks to other industries, and city employment shares across industries. The model provides a framework for a within-city test of the hypothesis that workers value pooled labor markets.

4.1 THEORY

Consider a one-period model with a set of locations, industries, and workers. Assume that industry location is fixed, but that workers are free to move costlessly between jobs or locations at the beginning of each period. For simplicity, I assume that firms in industry I and location c hire E_{ic} workers at the beginning of each period, where E_{ic} is expected employment in the industry for the location.¹² After the initial hires, employment shocks are realized in each industry and location, and firms may adjust their employment choices. For simplicity, assume that firms in each industry and each city commit at the beginning of each period to a fixed real wage for the entire period. I will discuss a way to relax this assumption below. Once the shocks are realized, employment is adjusted, production takes place, wages are paid, and utility is enjoyed.

¹²This assumption could be justified on the basis of risk-neutral firms and the existence of hiring and firing costs if employment is adjusted after shocks are realized.

Now consider a worker who receives a job offer at the beginning of a period. If the worker rejects the offer, he or she receives known expected utility y , which corresponds to the option value of the freedom to choose any location without a job, in the hopes of obtaining one once shocks are realized. If the worker accepts the job, he or she faces the risk of losing the job once shocks are realized, and being forced to search for a new job in the chosen location.

Our worker has received a job offer in industry I and location c . I assume that the worker retains this job with probability $\pi_i(\epsilon_{ic})$, where ϵ_{ic} is the proportional shock to employment in the industry-location pair. I assume that $\pi_i(0) < 1$, so that even in the absence of a shock there is some probability that the worker will lose the job. In addition, I assume that $0 < \pi'_i(\epsilon_{ic}) < 1$ and $\pi''_i(\epsilon_{ic}) < 0$. The upper bound on π' will prove useful in signing coefficients. It seems reasonable if one assumes that $\pi_i(0)$ is close to 1, and π is concave. I also assume that π and its derivatives have the same value for all industries when evaluated at a zero value of the shock. This assumption generates the same coefficient on pooling variables for all industries, and allows me to pool industries in the empirical section. I will subscript π as necessary to indicate which industry shocks are relevant.

If the worker loses the job, which occurs with probability $1 - \pi$, then he or she can search for another job in the same location. With probability R_i (a “reemployment” probability) the worker will find another job in industry I in the same location. The worker may find another job in the same industry in which he or she lost the job. The reemployment probabilities depend on all the industry shocks. To simplify the presentation, I will assume that workers who do not have jobs after the shocks are realized receive no income (although they may benefit from city

amenities). This assumption has no effect on the qualitative form of the risk premium expression or the sign of the coefficients.

A worker receiving a job offer will demand compensation sufficient to equate expected utility from accepting the offer to expected utility from rejecting it. Using the notation developed thus far, the expected utility condition can be written as follows:

$$E \left[\pi_I u(\omega_I) + (1 - \pi_I) \left[\sum_{k \in I} R_k u(\omega_k) - f \right] + a \right] = y \quad (8)$$

where the expectation is taken over the employment shocks to all industries in location c . The real wage in industry I is given by ω_I . The variable f is a fixed cost of searching for a new job, and a is the value of amenities in location c . For convenience, I have dropped the location subscript in (8). I assume that the fixed cost of searching for a new job is sufficient to ensure that $u(\omega_I) > \sum_k R_k u(\omega_k)$ for every industry.¹³ Otherwise, workers would never remain in industries for which this was not true, but would prefer to search for new jobs once they settled in a location.

The industry wage premium can be written as $\omega_i = \Delta_i + \omega_1$, where Δ_i is the wage premium in industry I (and location c) and ω_1 is some reference real wage. Using this notation, take a first-order Taylor approximation around $\Delta_k = 0$ for all k and a second-order approximation around $\epsilon_k = 0$ for all k . Ignoring the constant term, the approximation of (8) produces (on the LHS) terms involving the industry premia (which arise from the first-order approximation) and terms involving second derivatives and cross-derivatives of the shocks (which arise from the second-

¹³If there were unemployment compensation \underline{u} , I would have to assume $f > \sum R u(\omega) + (1 - \sum R) u(\underline{u})$.

order approximation). The algebra is straightforward (although a little messy). I will omit some of the details of the derivation. The premium terms are:

$$\pi u' \Delta_i + (1 - \pi) \sum_{k \in I} R_k u' \Delta_k \quad (9)$$

where all functions are evaluated at a zero value of all the variables. The second term in (9) is a constant for all industries in a location. The second-derivative terms are:

$$\frac{1}{2} \left[\pi'' u \sigma_i^2 - \pi'' \sum_{k \in I} R_k u \sigma_i^2 + \pi'' f \sigma_i^2 - \pi' \sum_{j \in I} \sum_{k \in I} \frac{dR_k}{d\epsilon_j} u \sigma_{ij} + (1 - \pi) \sum_{(i,j) \neq j \in I} \sum_{k \in I} \frac{d^2 R_k}{d\epsilon_i d\epsilon_j} u \sigma_{ij} \right] \quad (10)$$

where σ_i^2 is the variance of (proportional) employment shocks to industry I , σ_{ij} is the covariance of shocks to industries I and j , and again all functions are evaluated at a zero value of all the variables. The fourth term in (10) contains one variance term for industry I and one covariance term for this industry with each of the other industries. The fifth term is a constant for all industries in the same location. Note that the $\sum_k R_k < 1$ is sufficient to ensure that the coefficient on π'' is positive.

The intuition for the terms of (9) and (10) is straightforward. The premium for an industry (in (9)) depends on the premia in all other industries in the same location, since a worker may become unemployed and be forced to look for jobs in other industries. The first two three terms in (10) relate to the risk of losing a job. The fourth term is an interaction of the effects of shocks on the probability of keeping the original job and on the prospects for reemployment should the first job be lost. The final term indicates that, conditional on losing the first job, workers in all industries are in the same situation.

Before proceeding, more can be said about the R function. Call s_i the mean share of employment in industry I and E mean employment in location c . (Again I drop the c subscript.) I assume that firms in industry I hire $s_i E$ workers at the beginning of each period, then adjust this level of employment once shocks are realized. Thus, total employment in industry I at the end of the period will equal $(1+\epsilon_i)s_i E$. Subtract from this the number of workers who retain jobs in industry I -- $\pi_i s_i E$ -- to arrive at total jobs available in the industry once shocks are realized. The number of people looking for jobs equals the labor force (L), assumed constant, minus the number of workers who kept jobs in all industries -- $\sum_k \pi_k s_k E$. For simplicity I ignore any effect of the shocks on the size of the labor force. With this notation, the reemployment probability in industry I can be written as follows:

$$R_i = \frac{(1+\epsilon_i)s_i E - \pi_i s_i E}{L - \sum_{k \in I} \pi_k s_k E} = \frac{(1+\epsilon_i)s_i \bar{e} - \pi_i s_i \bar{e}}{1 - \sum_{k \in I} \pi_k s_k \bar{e}} \quad (11)$$

where \bar{e} is the mean employment rate in location c . This formulation assumes that workers who lose their initial jobs and unemployed workers enter the same job pool once shocks are realized, and that available jobs are distributed randomly among workers in this pool.

Equation (11) implies that the coefficients on the industry variance and covariance terms in the wage premium will differ across locations, since these coefficients depend on R and its derivatives, which in turn depend on the mean employment rate (\bar{e}) in the location. I can eliminate this difficulty by including in the wage premium calculation an approximation around a cross-sectional (across location) mean employment rate. In this case, each location will have the same coefficients on variables, but there will be a term involving the location mean employment rate in the industry premium. Since this term will be the same for all industries in a location, it

can be folded into a location fixed effect in the empirical work below. I will continue to write \bar{e} , which now will be taken to indicate the cross-sectional mean employment rate.

I can use the function R to solve for the terms in the industry wage premium. First note that $\sum_k R_k(0)\Delta_k = [\bar{e}(1-\pi)/(1-\pi\bar{e})]\sum_k s_k \Delta_k$, where the (0) indicates that R is evaluated at a zero value of the variables. The last summation term equals the expected location premium, *i.e.*, the share-weighted sum of industry premia in a location. The solution for $\sum_k R_k(0)\Delta_k$ can be substituted into (9). In addition, $\sum_k R_k(0) = [\bar{e}(1-\pi)/(1-\pi\bar{e})] < 1$, *i.e.*, the total probability of reemployment is less than one.

The last term in the wage premium expression (10) is a location constant. As a result, for my purposes I can ignore the second derivatives of the R function. The first derivative is relevant, however, for the covariance term that differs across industries. It is straightforward to show

$$\sum_{k \in I} \frac{dR_k(0)}{d\epsilon_i} = s_i \left(\frac{\bar{e}}{1-\pi\bar{e}} \right) \left(1 - \pi' + \frac{\bar{e}\pi(1-\pi)}{1-\pi\bar{e}} \right) \quad (12)$$

After substituting (12) into (10), the terms in (9) and (10) can be combined to write the risk premium approximation as follows:

$$\kappa + \alpha \Delta_i - \beta \sigma_i^2 - \gamma \sum_{k \in I} s_k \sigma_{ik} + C = y \quad (13)$$

$$\Delta_i = \frac{y - \kappa}{\alpha} + \frac{\beta}{\alpha} \sigma_i^2 + \frac{\gamma}{\alpha} \sum_{k \in I} s_k \sigma_{ik} - \frac{C}{\alpha} \quad (14)$$

where κ , α , β , and γ are positive constants. C is a location (city) constant of indeterminate sign. C will depend on the mean city premium (which could be positive or negative), the second derivative terms in (10) multiplied by the appropriate variance-covariance terms, and the value of amenities. According to (14), the wage premium for a given industry in a given location should increase with

the variance of employment shocks to that industry (in that location) and with the share-weighted sum of the covariances of that industry's shocks with the shocks to all industries in that location. In addition, there will be a constant location effect for all industries in each location. The term in (14) that includes the sum of the covariances (including the variance with the original industry) arises because the worker may become unemployed. If so, his or her prospects will depend on the shocks to all industries in a location. This term represents the labor market pooling effect, since it has to do with the covariances among industry shocks within a market.

Finally, I have assumed that real wages are set at the beginning of each period, which amounts to two assumptions, namely that wages are set in real terms and that wages are impervious to shocks. I have little to say about the former assumption. Without it, I need an assumption about how local prices respond to shocks to generate a real wage. It seems simplest to proceed with the real wage setting assumption. The assumption about wages remaining fixed in the face of shocks could be relaxed by assuming that industry premia are fixed in relation to the location wage, but the location wage is a random variable that responds to share weighted sum of shocks. This framework would produce the same qualitative variables for the wage premium as in (14), although the coefficients would be different and the coefficient on the pooling variable (the share-weighted sum of the covariances) would have indeterminate sign. With wage effects, extra covariance terms are added that reflect the interaction of the marginal effect of an industry shock on the probability of keeping a job (π') and the marginal effect of industry shocks on utility through the effect on the location wage. When the covariances are positive, this interaction makes a location more attractive, and tends to reduce the wage premium. In order for the total effect of the covariance terms on the premium to be positive, it is sufficient that utility not be too much less

than the marginal effect of shocks on utility (through the wage effect), when all variables are evaluated at a zero value of shocks.¹⁴ Essentially, this condition requires that the reference wage (the approximation point) not be too small. Intuitively, when wages are very low and utility is concave, the possibility that shocks may increase the wage weighs heavily in expected utility. As wages increase, this effect becomes smaller. In any event, since the qualitative form of the wage premium equation would not change, adding a location wage response to shocks would not change the empirical framework I set out below.

4.2 EMPIRICAL FRAMEWORK

The wage premium in (14) can be expressed in percentage terms by dividing by the cross-sectional mean wage. In step one of the estimation procedure, I use the CPS to compute a log earnings equation of the form

$$\ln(w_{kc}) = X'_k \delta + \Gamma_{ic} + \epsilon_{kic} \quad (15)$$

where k refers to individuals, I to industries, and c to cities. Γ_{ic} is a fixed effect for an industry-city pair. I collect the set of Γ_{ic} , then use these as data to estimate

$$\Gamma_{ic} = \beta_0 + \beta_1 \sigma^2_{ic} + \beta_2 LMP_{ic} + \Pi_c + v_{ic} \quad (16)$$

where σ^2_{ic} is the variance of shocks to industry I in city c ; $LMP_{ic} = \sum_j s_j \sigma_{ij}$, the share-weighted sum of covariances; and Π_c is a city fixed effect. Effectively, the regression in (16) explores whether within-city variances in wages are related to the variance of shocks across industries and the appropriate degree of pooling facing a given industry. The city fixed effects will control not only

¹⁴Adding a location wage response to shocks also has an effect on the constant location effect through the covariances. I refer here to the covariance terms that describe individual industry premia within each location.

for the constant portion of the real wage premium applicable to each location, but for differences in price levels across cities. This is important, since the regressions are in nominal terms, but the theory is about real wages.

4.3 DATA AND METHODOLOGY

As in Section 3, I use microdata from the CPS. I combine this data with sectoral employment data from County Business Patterns (CBP), which provides county-level, state-level, and US employment data by SIC for mid-March of each year. As part of a related research project, I have constructed city-level employment estimates based on county definitions for 34 cities for 1986-1993. I have aggregate U.S. data for 1985-1994. The city definitions have already been discussed. With respect to the sectoral data, CBP uses the SIC industry definition, and the CPS uses CIC definitions. For manufacturing industries, one can construct a fairly complete correspondence, although some of the residual CIC categories must be dropped in the CPS sample. This has no effect on the computation of the measures of labor market pooling, but does eliminate some workers in the CPS sample.¹⁵ I use a 3-digit CIC level of aggregation. Typically, 3-digit CIC categories correspond to 3-digit SIC categories, although some correspond to groups of 3-digit SIC categories, and some to 2-digit SIC categories. For service sectors, used in the construction of the labor market pooling variable, there is no need for a correspondence to the CPS. To limit computation, I use the 2-digit SIC level of aggregation for service sectors.

¹⁵I lose less than 50 workers a year from this problem. The total annual sample size varies between 10 and 15 thousand observations.

CBP withholds employment data when it will provide information about individual firms, *i.e.*, when individual firms account for a sizable portion of employment in an industry at the county level. In these cases, although CBP does not provide the precise level of employment, it does provide an indicator of the range of employment. I have filled in these missing cells of the data using an adjusted version of the aggregation procedure developed by Gardocki and Baj and described by Miracky (1995). This procedure is described in the Appendix.

Industry shocks for each city are constructed as residuals from a regression of log employment on one lag and a time trend. Using these shocks, I build a variance-covariance matrix by industry for each city. The construction of the labor market pooling variable also requires mean employment shares. Some industries have trending employment shares. Rather than use a separate set of shares for each year of the sample and adjust for the trends, I simply chose the shares in 1989 as a midpoint of the sample. For each city, I eliminate industries whose employment share drops to zero for any year of the sample. Then I adjust total employment for the omitted industries to get a denominator for the share. The labor market pooling variable for a given industry-location set is simply the share-weighted sum of covariances of shocks to the industry with shocks to all industries in location, as given in (14).

Since the time series for the employment shocks is short, one might be concerned about measurement error in the industry variance and labor market pooling variables. As a remedy, I construct an instrument for each variable using U.S. aggregate information. I construct the U.S. industry covariance matrix in the same manner as I construct each city's matrix. As an instrument for industry variance in a location, I use industry variance at the U.S. level. As an instrument for the labor market pooling, I use the covariances at the U.S. level weighted by local shares.

4.4 RESULTS

I begin by using the CPS sample to estimate wage premia for industry-city pairs for each of my sample years. A problem with this approach is that some of the industry-city pairs have a small number of observations. As a first pass, I limit attention to industry-city pairs with 50 or more observations. This produces a sample of approximately 300 observations over the eight years of data. Using this sample, the results of the second stage regression are presented in first column of Table 4.

The dependent variable in Table 4 is the industry-city wage premium. On the RHS are a constant, the variance of shocks to the industry in the city, the labor market pooling variable (LMP), city fixed effects, and year dummies. Recall that for industry I , $LMP = \sum_k \sigma_{ik}$. The time dummies are required because the logic of the risk premium derivation requires a single reference wage--for my purposes, something akin to a mean wage over all the years of my sample. The annual wage premia are mean zero over the yearly sample. The time dummies correct for the yearly differences in means. In principle, instead of separate time and city dummies, one might want to allow the city fixed effects to vary over time, a procedure which effectively adds a time fixed effect. This approach would allow the city wage to respond to annual shocks, while constraining the within-city industry premium to be fixed, and thus would correspond to the extension of the basic model described at the end of section 4.1. I have run the OLS regressions in Table 4 with time-varying city fixed effects, and the coefficients and standard errors for the industry variance and LMP variables are almost identical to those reported.

Table 4: Within City Wage Premia and Labor Market Pooling

OLS regressions report heteroskedasticity-robust (Huber) standard errors. The dependent variable is the nominal within-city wage premium for an industry-city pair. LMP is the labor market pooling variable. IV regressions use the U.S. industry variance as an instrument for local industry variance, and the U.S. covariance matrix of employment shocks weighted by local employment shares as an instrument for LMP. The specifications include year dummies and city fixed effects.

	OLS/ Huber s.e. Large-Sample (n>=50) industry-city pairs	OLS/ Huber s.e. All industry- city pairs	IV Large-Sample (n>=50) industry-city pairs	IV All industry- city pairs
Variance of industry shocks	3.616	0.176	19.977	1.32
	(0.416)	(0.026)	(13.261)	(0.233)
LMP (Share-wgtd. sum of covariances)	62.808	-1.656	494.459	-165.445
	(9.558)	(1.123)	(346.472)	(38.365)
Observations	298	8555	298	8555
R ²	.423	.089	-----	-----

The results in column 1 of Table 4 support the labor market pooling model described above. The coefficients on industry variance and the LMP variable are positive and significant at the 1% level. One could stop here, but three issues are troubling. The first is that limiting the sample to industry-city pairs with 50 or more observations throws away a great deal of data. The second is that the number of observations is correlated with local employment share. Finally, the coefficient estimate on the LMP variable implies an implausibly large effect. An increase of one (cross-sectional) standard deviation in the LMP variable would be associated with a 41.2 percentage point increase in the within-city wage differential.

On the first issue, use of the entire sample should not bias the results. The industry-city pairs with a small number of observations will have imprecise estimates of the wage premium. This will add measurement error to the LHS variable, which will be incorporated in the regression error. Essentially, the extra observations will add noise.

On the second issue, the mean share for all industry-city pairs over the entire sample is about 0.6%. The mean share for those pairs with 50 or more observations is about 1.2%, almost twice as large. Within the model I have presented, there is no basis for a share effect beyond the share component of the LMP variable. Still, given the differences in share between the restricted sample and the overall sample, it is something that should be investigated.

The second column of Table 4 presents the results of the second stage regression using the whole sample of industry-city pairs. The coefficient on industry variance is positive and significant, but the coefficient on LMP is negative and insignificant.

Before investigating the source of the different results in columns 1 and 2, I note that the industry variance and LMP variables may have substantial measurement error, since the variables are constructed on the basis of a short time series. To address this concern, I run instrumental variables regressions using the U.S. industry variance as an instrument for the local industry variance, and the sum of U.S. industry covariances weighted by local employment shares as an instrument for the LMP variable. The results are presented in columns 3 and 4 of Table 4. The coefficients on industry variance and LMP become larger in magnitude. The coefficients lose significance for the subsample of industries with 50 or more observations; the coefficient on LMP becomes significantly negative for the entire sample.

The most obvious difference between the subsample and the full sample is that industry share is larger, on average, in the subsample. To investigate whether share has anything to do with the differing results, I run another set of second stage regressions (see Table 5), adding employment share as a variable, as well as interactions of the share with the industry variance and LMP variables. There is no clear theoretical reason to choose this specification, but it seems a straightforward robustness check along the dimension of share. The first column in Table 5 presents the results of this specification for the restricted sample of industry-city pairs with 50 or more individual observations; the second column presents results using the whole sample.

Table 5: Within City Wage Premia, Industry Share, and Labor Market Pooling

OLS regressions with heteroskedasticity-robust (Huber) standard errors. The dependent variable is the nominal within-city wage premium for an industry-city pair. LMP is the labor market pooling variable. The specifications include year dummies and city fixed effects.

	Large-Sample (n \geq 50) industry-city pairs	All industry-city pairs
Industry share of local employment	-4.548	3.203
	(1.066)	(0.312)
Variance of industry shocks	0.039	0.162
	(1.002)	(0.034)
Share*Variance	-29.367	9.322
	(127.686)	(4.983)
LMP (Share-wgtd. sum of covariances)	-62.319	-2.714
	(20.348)	(1.211)
Share*LMP	9116.139	-77.813
	(1250.316)	(95.308)
Observations	298	8555
R ²	.479	.097

The full-sample results in column two of Table 5 indicate that industry share of local employment has a strong and positive association with within-city wage differentials. After controlling for the share variables, there is a significant negative association of wage differentials with the LMP variable, a result at odds with the labor market pooling hypothesis. By contrast, share has a significant negative association with wage differentials for the restricted sample with 50 or more observations in each industry-city cell. The positive coefficient on the interaction of the LMP and share variables indicates that LMP begins to have a positive effect of wage differentials for a large enough share (the critical value is 0.68%).

It is not clear how one should interpret these results. Although wage premia for industry-city pairs with small numbers of observations may be estimated imprecisely, it is not clear why they would collectively be biased towards zero. The imprecision should add noise, not a mean effect. So the full-sample evidence suggests that share matters, although this effect is not relevant to the labor market pooling model presented here. It is tempting to think that share may capture some scale effect. Since the regression includes city fixed effects, however, it is analyzing within-city differences in wages. It is not clear why mobility across sectors would not arbitrage the differential.

Further speculation about the role of employment share in wage differentials is beyond the scope of the present enterprise. I read the evidence as offering little support for the within-city prediction about the relationship between labor market pooling and wage differentials.

5. CONCLUSION

In this paper I have explored the hypothesis that workers value pooled labor markets. I have considered two models. In the first, workers chose locations before they have jobs. This model gives rise to a location wage effect. In the second model, workers chose locations and jobs simultaneously. This model provides a prediction about within-city variation in wages.

Evidence on the value of pooling to workers is mixed. Results for the cross-city model imply that increases in the variance of the local employment rate would be associated with increases in the local real wage premium. This result is consistent with the idea that risk-averse workers favor pooled labor markets. On the other hand, the results also suggest that increases in the mean local employment rate would be associated with increases in the local real wage premium. The latter result is inconsistent with a compensating differential framework. Since there is no clear theoretical prediction about the relationship pooling and the mean employment rate, the effects of the mean on real wage premia remain a puzzle within the context of this paper.

The evidence presented here does not offer much support for the within-city model. Although the model seems to fit for industry-city pairs for which I have a large sample (50 or more observations), the model does not fit for the full sample of industry-city pairs. A preliminary examination of these differences has uncovered a relationship between local employment share and within-city wage differentials, for reasons that remain unclear.

APPENDIX

A.1 CITY DEFINITIONS

To build the city employment data set borrowed from other ongoing research, I first constructed city definitions according to their 1979 SMSA definitions. Then I attempted to match these definitions to the more recent CPS definitions (post-1985). Since the CPS designates individual PMSAs in larger CMSAs, it is possible to build a CPS sample that matches the earlier definitions reasonably closely. In cases where changing definitions implied that the post-1985 CPS cities, even as reconstructed, would include extra counties, I added these counties back to my city definitions. Boston is the one exception to this procedure. The Census defines New England cities by townships, rather than counties. I employed a county definition for Boston to approximate the Census township definition. The 34 cities used in the analysis, and the counties they comprise, are listed below.

Birmingham, AL

Blount County, AL
Jefferson County, AL
St. Clair County, AL
Shelby County, AL
Walker County, AL

Los Angeles, CA

Los Angeles County, CA
Orange County, CA
Riverside County, CA
San Bernardino County, CA

Sacramento, CA

El Dorado County, CA
Placer County, CA
Sacramento County, CA
Yolo County, CA

San Diego, CA

San Diego County, CA

San Francisco, CA

Alameda County, CA
Contra Costa County, CA
Marin County, CA
Santa Clara County, CA
San Francisco County, CA
San Mateo County, CA

Denver, CO

Adams County, CO
Arapahoe County, CO
Boulder County, CO
Clear Creek County, CO
Denver County, CO
Douglas County, CO

Denver, CO (cont.)

Gilpin County, CO
Jefferson County, CO

Washington, DC

District of Columbia, DC
Calvert County, MD
Charles County, MD
Frederick County, MD
Montgomery County, MD
Alexandria City, VA
Fairfax City, VA
Falls Church City, VA
Manassas City, VA
Manassas Park City, VA
Arlington County, VA
Fairfax County, VA
Loudoun County, VA
Prince William County, VA
Stafford County, VA

Miami, FL

Dade County, FL

Tampa, FL

Hernando County, FL
Hillsborough County, FL
Pasco County, FL
Pinellas County, FL

Atlanta, GA

Barrow County, GA
Butts County, GA
Cherokee County, GA
Clayton County, GA
Cobb County, GA
Coweta, Ga
De Kalb County, GA
Douglas County, GA
Fayette County, GA
Forsyth County, GA
Fulton County, GA
Gwinnett County, GA

Atlanta, GA (cont.)

Henry County, GA
Newton County, GA
Paulding County, GA
Rockdale County, GA
Spalding County, GA
Walton County, Ga

Chicago, IL

Cook County, IL
Du Page County, IL
Grundy County, IL
Kane County, IL
Kendall County, IL
Lake County, IL
McHenry County, IL
Will County, IL
Lake County, IN
Porter County, IN

Indiannapolis, IN

Boone County, IN
Hamilton County, IN
Hancock County, IN
Hendricks County, IN
Johnson County, IN
Marion County, IN
Morgan County, IN
Shelby County, IN

New Orleans, LA

Jefferson Parish, LA
Orleans Parish, LA
St. Bernard Parish, LA
St. Charles Parish, LA
St. John Parish, LA
St. Tammany Parish, LA

Boston, MA

Essex County, MA
Middlesex County, MA
Norfolk County, MA
Suffolk County, MA

Baltimore, MD

Baltimore City, MD
Anne Arundel County, MD
Baltimore County, MD
Carroll County, MD
Harford County, MD
Howard County, MD
Queen Anne's County, MD

Detroit, MI

Lapeer County, MI
Livingston County, MI
Macomb County, MI
Monroe County, MI
Oakland County, MI
St. Clair County, MI
Wayne County, MI

Minneapolis, MN

Anoka County, MN
Carver County, MN
Chisago County, MN
Dakota County, MN
Hennepin County, MN
Isanti County, MN
Ramsey County, MN
Scott County, MN
Washington County, MN
Wright County, MN
St. Croix County, WI

Kansas City, MO

Johnson County, KS
Leavenworth County, KS
Miami County, KS
Wyandott County, KS
Cass County, MO
Clay County, MO
Jackson County, MO
Lafayette County, MO
Platte County, MO
Ray County, MO

St. Louis, MO

Clinton County, IL
Jersery County, IL
Madison County, IL
Monroe County, IL
St. Clair County, IL
St. Louis City, MO
Franklin County, MO
Jefferson County, MO
St. Charles County, MO
St. Louis County, MO

Greensboro, NC

Davidson County, NC
Davie County, NC
Forsyth County, NC
Guilford County, NC
Randolph County, NC
Stokes County, NC
Yadkin County, NC

Albany, NY

Albany County, NY
Greene County, NY
Montgomery County, NY
Rensselaer County, NY
Saratoga County, NY
Schenectady County, NY

Buffalo, NY

Erie County, NY
Niagara County, NY

New York, NY

Bergen County, NJ
Essex County, NJ
Morris County, NJ
Passaic County, NJ
Sussex County, NJ
Union County, NJ
Bronx County, NY
Kings County, NY
Nassau County, NY

New York, NY (cont.)

New York County, NY
Putnam County, NY
Queens County, NY
Richmond County, NY
Rockland County, NY
Suffolk County, NY
Westchester County, NY

Rochester, NY

Livingston County, NY
Monroe County, NY
Ontario County, NY
Orleans County, NY
Wayne County, NY

Cincinnati, OH

Dearborn County, IN
Boone County, KY
Campbell County, KY
Kenton County, KY
Clermont County, OH
Hamilton County, OH
Warren County, OH

Cleveland, OH

Cuyahoga County, OH
Geauga County, OH
Lake County, OH
Medina County, OH
Portage County, OH
Summit County, OH

Columbus, OH

Delaware County, OH
Fairfield County, OH
Franklin County, OH
Licking County, OH
Madison County, OH
Pickaway County, OH
Union County, OH

Portland, OR

Clackamas County, OR
Multnomah County, OR
Washington County, OR
Yamhill County, OR

Philadelphia, PA

Burlington County, NJ
Camden County, NJ
Gloucester County, NJ
Bucks County, PA
Chester County, PA
Delaware County, PA
Montgomery County, PA
Philadelphia County, PA

Pittsburgh, PA

Allegheny County, PA
Beaver County, PA
Fayette County, PA
Washington County, PA
Westmoreland County, PA

Dallas, TX

Collin County, TX
Dallas County, TX
Denton County, TX
Ellis County, TX
Johnson County, TX
Kaufman County, TX
Parker County, TX
Rockwell County, TX
Tarrant County, TX

Houston, TX

Brazoria County, TX
Fort Bend County, TX
Harris County, TX
Liberty County, TX
Montgomery County, TX
Waller County, TX

Seattle, WA

King County, WA

Snohomish County, WA

Milwaukee, WI

Milwaukee County, WI

Ozaukee County, WI

Washington County, WI

Waukesha County, WI

A.2 MISSING CELLS IN COUNTY BUSINESS PATTERNS

Data on employment is withheld from County Business Patterns in cases where disclosure would violate confidentiality agreements. In these cases, CBP lists a variable that provides a range for employment, but not the actual employment in the given industry. CBP, however, also provides data on the number of establishments by industry for each county. The establishment data are not withheld. Using the establishment data, Gardocki and Baj (1985) have developed a method to fill in missing CBP cells. This procedure is described in Miracky (1995). When an industry-county cell is missing, Gardocki and Baj find the ratio of employment to establishments at the closest level of aggregation that has a nonmissing observation for the given industry. They then apply this ratio to the establishment data for the missing cell. If the result falls outside the range indicated by the CBP, the nearest endpoint of this range is substituted. For Gardocki and Baj, the aggregation hierarchy is county, state, U.S. I follow the same procedure to fill in missing cells in my data set, but I use the aggregation hierarchy of county, city, state, U.S.

CHAPTER 3: DISTANCE, MARKET SIZE, AND WAGE DIFFERENTIALS ACROSS U.S. CITIES

1. INTRODUCTION

Recent research in economic geography (notably Krugman (1991a, 1991b, 1996)) has emphasized the interconnected roles of scale, market size, and transport costs in creating spacial agglomeration. Many of the models in this literature imply that, all else equal, firms should find it advantageous to locate near large markets, since such location minimizes transport costs, which are assumed to rise with distance. On the assumption that firm benefits translate into worker benefits, this paper investigates whether distance and market size variables can account for differences in nominal wages across U.S. cities. In particular, I postulate that the U.S. economic landscape is dominated by three market hubs--New York, Los Angeles, and Chicago--and ask whether distance to the nearest hub is an important correlate of wage differentials, after controlling for local market size. The results provide preliminary evidence that indeed distance does matter. In pooled regressions, an increase of 100 miles from the nearest hub is associated with a 1 percentage point fall in nominal manufacturing wages. In regressions which allow for separate effects by hub, the distance effect is similar in Chicago and New York, but not significantly different from zero in the Los Angeles region. Wages in services also fall with distance to the nearest hub, but the effect is not as strong. Real wages, by contrast, seem to rise with distance from a hub. I read the evidence on nominal manufacturing wages as broadly consistent with the modern geography literature. In addition, the results for

nominal manufacturing wages, coupled with the evidence on real wages and nominal wages in services, provide some first-order facts about the relationship between distance and U.S. wage differentials across cities.

The paper proceeds as follows. Section 2 discusses some of the literature on economic geography as well as an apparently related trade literature on gravity models, in which distance and market size variables matter. Section 3 describes an estimation strategy, and Section 4 discusses data and results. An appendix lists the cities used in the analysis.

2. DISTANCE AND MARKET SIZE MODELS

The effect of market size on wages in the presence of scale economies and transport costs was made clear by Krugman (1980) in the context of a model of international trade, with immobile factors. A larger local market tends to be advantageous to firms because it allows them to exploit scale economies. In addition, with balanced trade, transport costs (of the "iceberg" variety) act as a terms of trade effect. Proximity to large markets (and thus large centers of demand) reduces transport costs and thus increases the effective price per unit of production. In order to maintain employment in all countries, firms must be compensated by lower nominal wages in smaller and more remote countries.

The modern geography models (e.g., Krugman (1991a, 1991b, 1996)) emphasize the same variables of scale and transport costs to illustrate how mobile factors might come to organize themselves into large economic centers. The basic idea is that scale provides an incentive for a firm to minimize the number of locations. If transport costs are positive, but not too high, firms will want to minimize such costs by locating near large markets. If transport

costs are large enough, however, it make sense for firms to have multiple locations, thus reducing agglomeration, even at the expense of losing scale economies.

Labor also benefits from agglomeration in the modern geography models. The models typically assume monopolistic competition and Dixit-Stiglitz preferences, in which utility is defined over all varieties of goods. In this framework, an increase in the size of a location is equated with the production of more varieties of goods. As a result, the bigger the location, the bigger the share of local consumption of manufactured goods that is produced locally. Since local production does not face transport costs, the true price index of manufactures is lower in bigger locations than smaller ones. Thus, at equal nominal wages across locations, workers would enjoy a higher real wage (in terms of manufactures) in larger economic centers.

Solving the Krugman style of geography model turns out to be difficult with more than two regions. In two region models, the result is typically all or nothing, either manufacturing is completely concentrated in one region, or equally distributed. (The existence of an immobile agricultural sector equally-spaced across regions means that both regions survive in either case.) Multiple region models typically must be solved numerically (Krugman, 1996).

In the context of a multi-region world, it seems clear that the original Krugman insight about market size, distance, and wages should survive. Proximity to large markets should be valuable from the firm's point of view. Thus, in the context of mobile firms, equilibrium requires that firms be compensated by lower wages in more remote economic centers. Although mobility of existing firms may be limited (*e.g.*, by fixed startup costs in new locations), new firms should arbitrage wage differentials to account for location advantages.

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associated with higher consumer price indices, not lower ones, if larger markets mean higher land prices and higher congestion costs generally. From the point of view of workers, such markets require higher nominal wages to equalize real wages across locations. The question is why manufacturing firms pay them in bigger markets. From the point of view of geography models, the answer is that such markets are beneficial because they reduce the share of production that must face transport costs. To preview the empirical results below, it is true that larger markets (in terms of population) tend to have higher nominal wages, but it seems disingenuous to argue that this result is driven by transport costs, given that the local share of total consumption for manufactures is likely to be small. On the other hand, firms that pay higher wages in larger markets must be compensated by some sort of productivity benefit. Some possibilities are external economies of scale and sorting of workers based on unobservable productivity differences (unobservable because the empirical analysis uses microdata to control for observables). In any case, geography theories suggest that market size should matter, and I include it as a control variable in the empirical work below.

In addition to the modern geography models, distance and market size variables have a long history of use in international trade (Deardorff (1984)). So-called gravity models use a log linear function of the distance between locations and the economic sizes of these locations to explain bilateral trade, usually with considerable success. There have been attempts to generate a theoretical footing for such models (Anderson (1979), Bergstrand (1985, 1987), and numerous others), usually in a monopolistic competition framework. The now standard Helpman and Krugman (1985) monopolistic competition framework for trade does generate a result that trade between locations in a two-region model depends on a constant multiplied by the product of the

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distances from regional centers. On other hand, one might interpret this paper as investigating whether wage gradients exist on a large scale across the U.S.

3. EMPIRICAL FRAMEWORK

I want to investigate whether proximity to large markets matters for wages, as suggested by the discussion in the previous section. I begin by postulating that the U.S. can be divided into three economic centers--New York, Los Angeles, and Chicago--around which regional activity is organized. I expect that the important distance variables for city wages are distances to these hubs, particularly to the nearest hub. In essence, this amounts to assuming that access to a regional hub is equivalent to access to the entire regional market, and possibly that access to the nearest hub is equivalent is access to the entire country. In principle, one might want to construct a distance measure for each city that weights the market sizes of all other cities by some function which decreases with distance. My sample of cities is not comprehensive enough for such a construction, however, and I do not have a clear theory to guide the weighting function. The assumption of regional centers is a convenient simplification which seems reasonably consistent with a superficial glance at the distribution of economic activity across the U.S. The assumption also puts some structure on the empirical analysis. I choose driving distance (along trucking routes) as the distance measure for convenience and because it seems more closely related to transport costs than distance as the crow flies.

In addition to distance from market centers, market size should also matter. First, there is the market size of the region, which can be handled with fixed effects, and second, there is local

distances from regional centers. On other hand, one might interpret this paper as investigating whether wage gradients exist on a large scale across the U.S.

3. EMPIRICAL FRAMEWORK

I want to investigate whether proximity to large markets matters for wages, as suggested by the discussion in the previous section. I begin by postulating that the U.S. can be divided into three economic centers--New York, Los Angeles, and Chicago--around which regional activity is organized. I expect that the important distance variables for city wages are distances to these hubs, particularly to the nearest hub. In essence, this amounts to assuming that access to a regional hub is equivalent to access to the entire regional market, and possibly that access to the nearest hub is equivalent is access to the entire country. In principle, one might want to construct a distance measure for each city that weights the market sizes of all other cities by some function which decreases with distance. My sample of cities is not comprehensive enough for such a construction, however, and I do not have a clear theory to guide the weighting function. The assumption of regional centers is a convenient simplification which seems reasonably consistent with a superficial glance at the distribution of economic activity across the U.S. The assumption also puts some structure on the empirical analysis. I choose driving distance (along trucking routes) as the distance measure for convenience and because it seems more closely related to transport costs than distance as the crow flies.

In addition to distance from market centers, market size should also matter. First, there is the market size of the region, which can be handled with fixed effects, and second, there is local

important than the distance to the other hubs; and to allow for different coefficients across regions. In addition, I will experiment with the functional form of the distance variable.

Apart from the distance variable, I implement (2) in logs. The style of the Krugman geography models, which employ a monopolistic competition framework, typically produces log-linear equations. Moreover, the gravity framework, which has been an empirical success in international trade (and which also rests on monopolistic competition, to the extent it has any theoretical justification), also relies on a log-linear functional form. A log specification for the distance variable, however, makes less sense. It would imply that equal percentage changes in distance from a hub have identical effects on wage premia, regardless of the initial distance from the hub (i.e., moving 6 to 12 inches would have the same effect as moving 300 to 600 miles). I choose instead to start with a linear distance variable and then experiment with a quadratic term.

Equations (1) and (2) can be implemented for a cross-section in any one time period. In practice, some of the cities in the CPS in any one year have only a small number of individual observations (i.e., less than less 40). I implement (1) separately for 6 years, 1986-1991, stack all the city premia, then implement (2).² Specifically, I use a sample of the 101 largest cities, omit the dummy for the 101st city (Huntington, WV) for each year, and obtain coefficient estimates for the top 100 cities. I subtract the mean premium (over Huntington) in each year. In equation (2), I use population in one year, 1990, as representative of city size. Since my RHS variable has no time variation, stacking the city wage premia is equivalent (with respect to point estimates) to averaging the wage premia over the six sample years for each city, then regressing the average

²It should be noted that about half of the CPS sample from one year will be included in the sample in the subsequent year. Thus, city premia across years might not be independent, if the individuals in the sample have unobserved characteristics important for wage determination

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manufacturing. In particular, I include the CIC categories of construction, wholesale and retail trade, private household services, repair services, personal services, entertainment and recreation services, and social services.

Finally, I will combine the data on nominal wage premia with data on city price levels to construct real wage premia. For city prices, my primary source is the American Chamber of Commerce index. I use the third-quarter observation for the central city of each of my metropolitan areas to construct real wages for each year of my sample. Missing observations reduce the real wage sample to between 60 and 75 observations per year. Although this price index has some problems (see Chapter 2 for a discussion), it is the only readily available cross-section city price index of which I am aware. Professor William Wheaton at M.I.T. has provided me with alternative price index for a subset of my cities (27) for 1988-89. This index is derived from an experimental study by BLS staff and uses BLS data for July 1988 to June 1989. (See Chapter 2 for a discussion). I will run regressions separately for 1989, using the BLS-derived and Chamber of Commerce indices as alternatives.

In equilibrium, real wage premia across locations should reflect amenity differences in utility for workers. A long literature investigates the effects of amenities on wages (e.g., Beeson and Eberts (1989), Gerking and Weireck (1983), Roback (1982)). From this perspective, distance from large markets should influence consumption wages only to the extent that such distance provides some amenity or disamenity. For example, if New York is a valuable location because of the range of cultural opportunities it provides, and distance from New York limits access to these opportunities, then real wages might rise with distance to New York to compensate for the disamenity. Only the valuation of the marginal worker would matter for this

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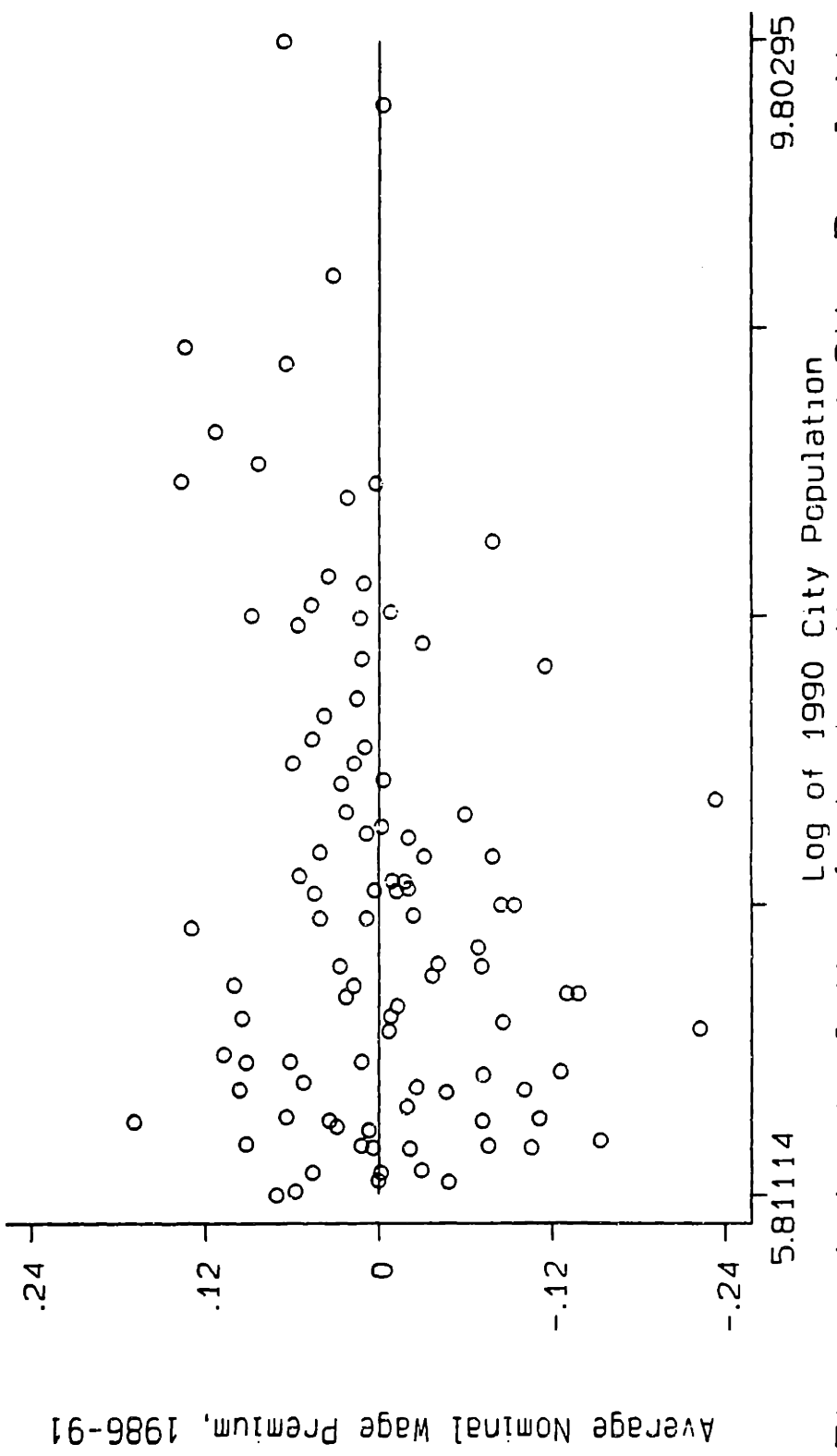


Figure 1: Nominal Manufacturing Wages and City Population

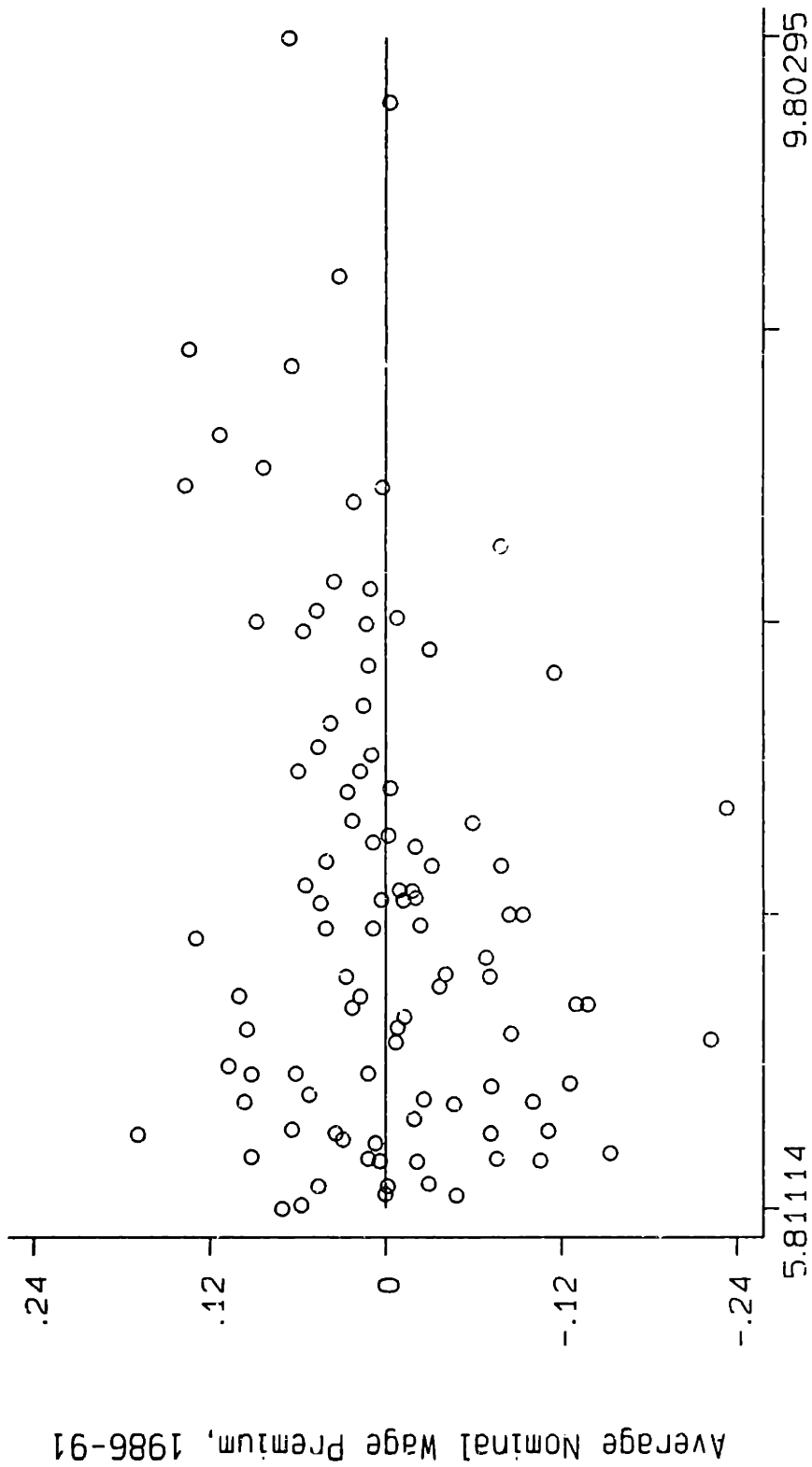


Figure 1: Nominal Manufacturing Wages and City Population

El Paso). The nominal premium seems to rise with population for both manufacturing and services, perhaps more strongly for services.³

Turning to real premia, Figure 3 plots the average real manufacturing premium (using Chamber of Commerce prices) against the log of city population. As noted in Section 3, some price observations are missing. There are only 40 cities for which prices are available for all six years of my sample. Figure 3 plots for each city the average real premium over as many years as are available. I have subtracted the overall sample average real premium to center the plot around zero. The individual points in Figure 3 may not be comparable since averages for some cities are based on one or two observations. As an alternative, Figure 4 plots the real manufacturing premium for 1989, the year in which I have the most observations. Figure 5 plots the real manufacturing index for 1989 using the BLS-derived index provided by Professor Wheaton.

Two points emerge from Figures 3, 4, and 5. First, real manufacturing wages seem to fall with population. Second, the range of real premia is at least as large as the range of nominal premia. The range of the average premia using the Chamber of Commerce prices is about 57% (Youngstown minus New York), somewhat larger than the range of nominal premia. In 1989, range is 47% (Baton Rouge minus San Francisco) using the Chamber of Commerce Prices. The range of the spread is about 30% in 1989 using the BLS-derived prices, but this sample does not include the smaller cities, which tend to have larger real wages. The 1989 BLS-derived price

³Johnson (1983) computed city wage premia using the CPS for the period 1973-1976. His city sample was necessarily smaller, since the CPS identified fewer metropolitan areas at the time. For the cities common to his sample and mine, the overall magnitudes of wage premia are roughly similar, although the premia differ city by city.

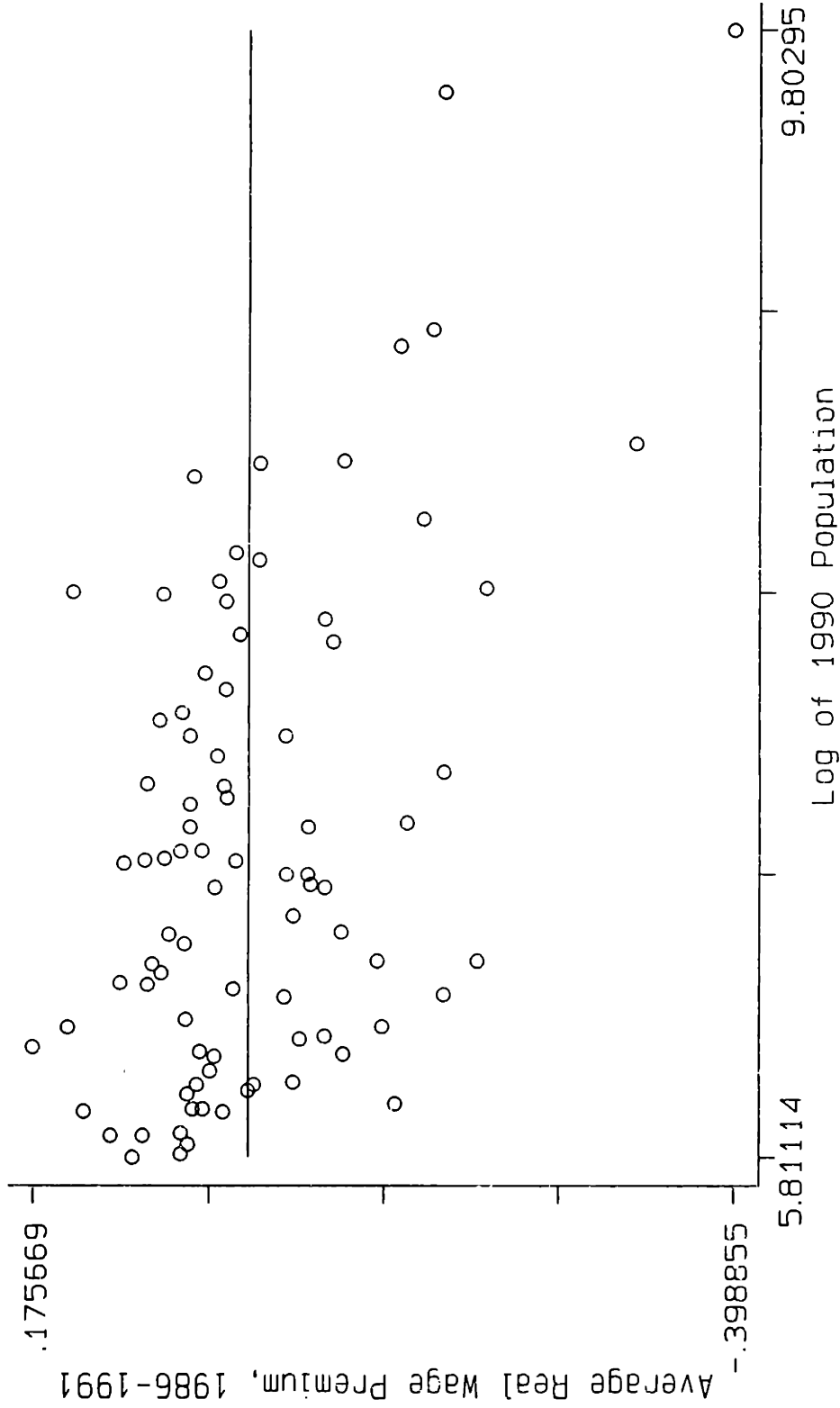


Figure 3: Real Manufacturing Wages and City Population

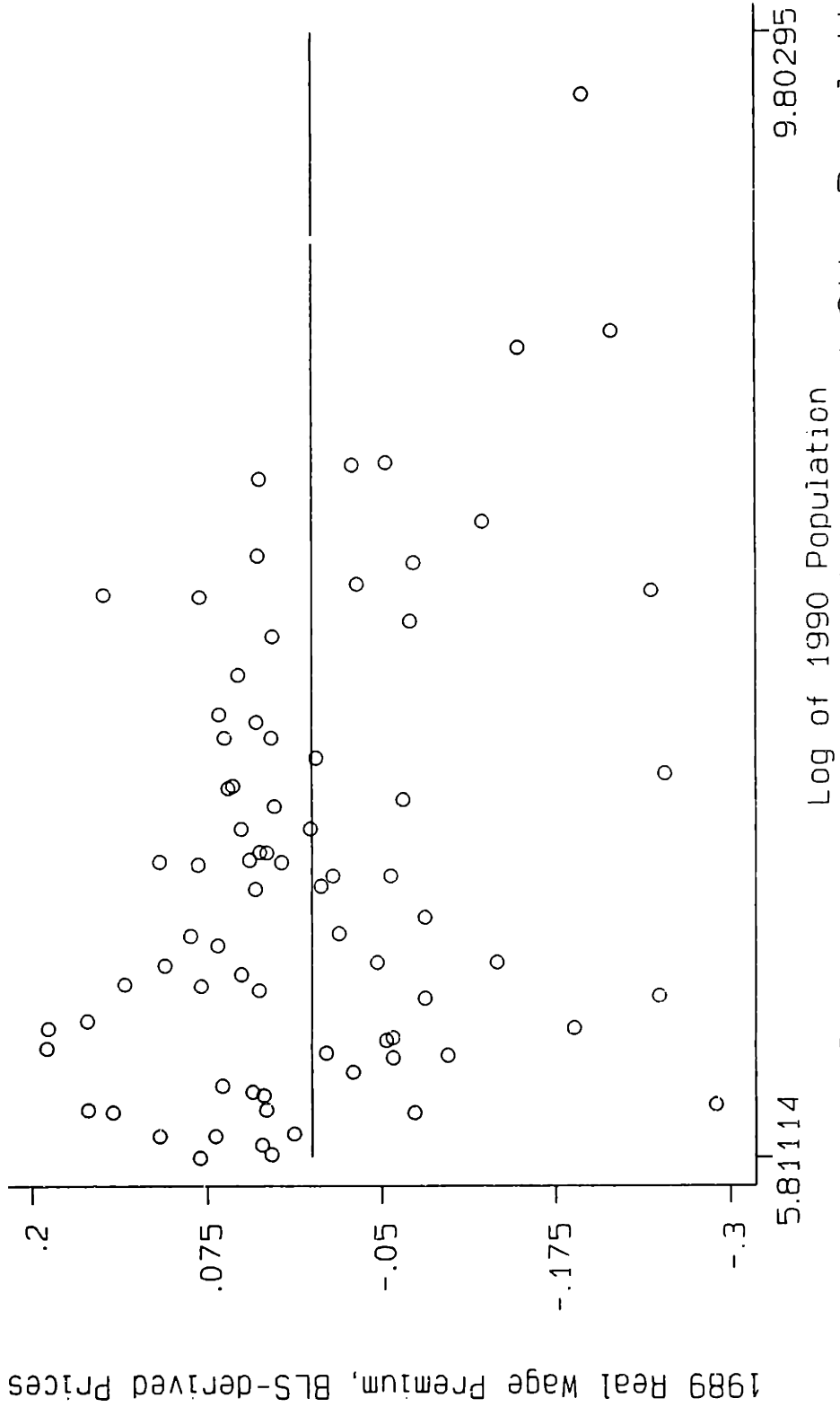


Figure 4: 1989 Real Manufacturing Wages and City Population

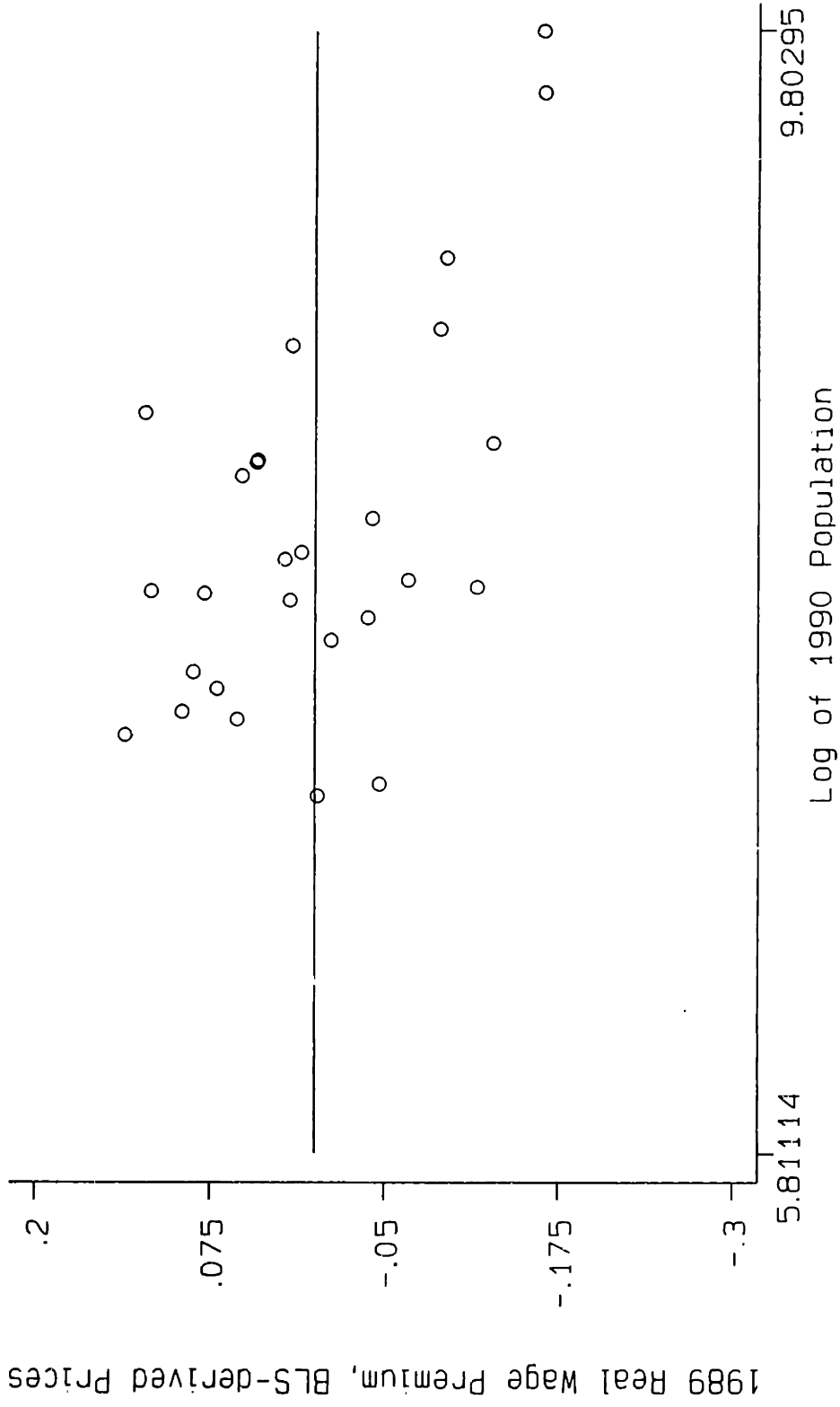


Figure 5: 1989 Real Manufacturing Wages and City Population

sample does include New York and Boston, however, which the 1989 Chamber of Commerce sample does not. In the average data, the range of the spread is driven by New York and Boston, which have large price indexes and relatively low real wages. New York has a price index as high as 213 (in 1991) and Boston as high as 164 (in 1988). In the 1989 BLS-derived sample, New York has an index of 128 and Boston of 127.7. Since these are cross-sectional indexes, the implication is that prices in these cities are relatively lower in the BLS-derived sample than in the Chamber of Commerce sample. One possible explanation for the difference is housing prices. As noted above, the Chamber of Commerce does not provide CMSA price indices, but narrower MSA ones. I use the MSA of the central city of each CMSA. In this regard, one concern is that the housing prices faced by a mid-management executive household in Manhattan may not be representative of housing costs faced by the average worker in the broader New York area. On the other hand, workers who live in the suburbs presumably pay for this in commuting time and the loss of other amenities. Hence, if local housing markets work smoothly, perhaps a comparison of central city housing prices across locations is warranted.⁴

Figures 6, 7, and 8 plot real wage premia in services. The spreads are also as large or larger than the corresponding nominal premia. The relationship with population again seems negative, but weaker than the manufacturing relationship, and perhaps driven by outliers.

Having taken a preliminary look at the wage premia from the first state regressions, I now turn to second stage results. Table 1 presents regressions of manufacturing and services nominal wage premia against the logarithm of 1990 city population and various functional forms of

⁴Johnson (1983) estimated real city for 1973-76 as well, using a BLS price index that was available at the time. He substituted nearby city price indexes for some missing observations. The magnitude of real wage differentials for the cities in his sample is much narrower than the corresponding magnitude in my sample.

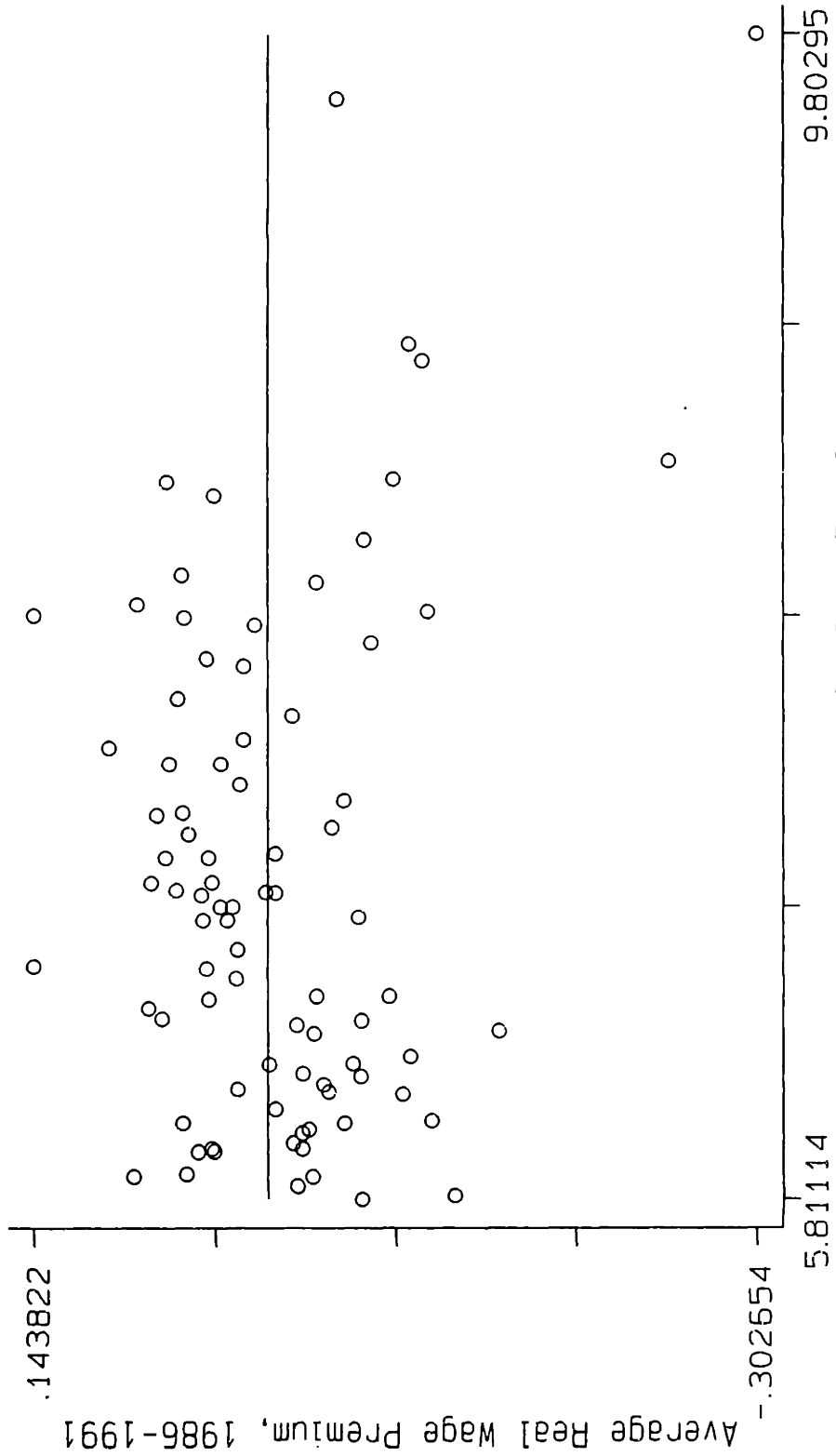


Figure 6: Real Services Wages and City Population

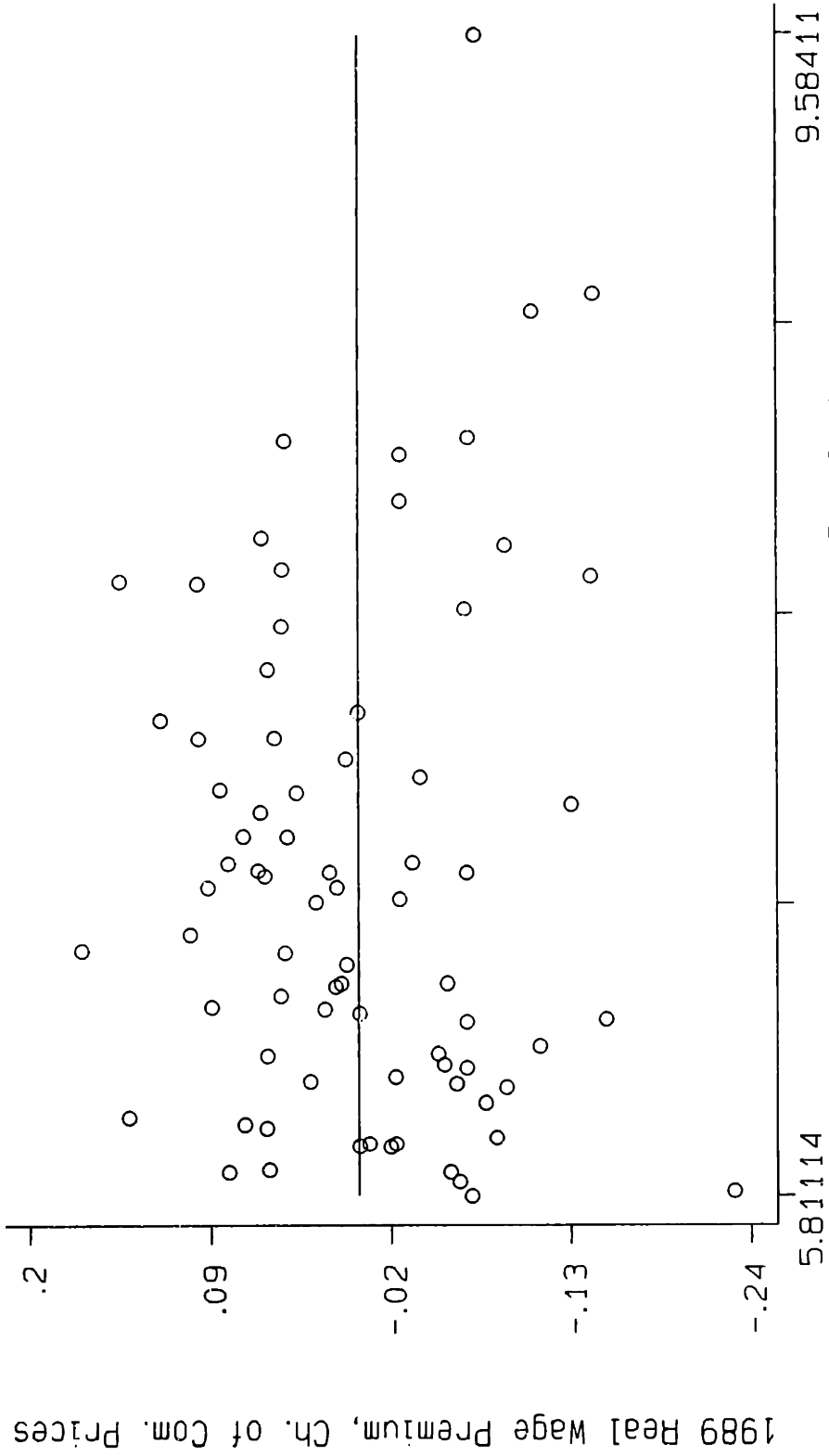


Figure 7: 1989 Real Services Wages and City Population

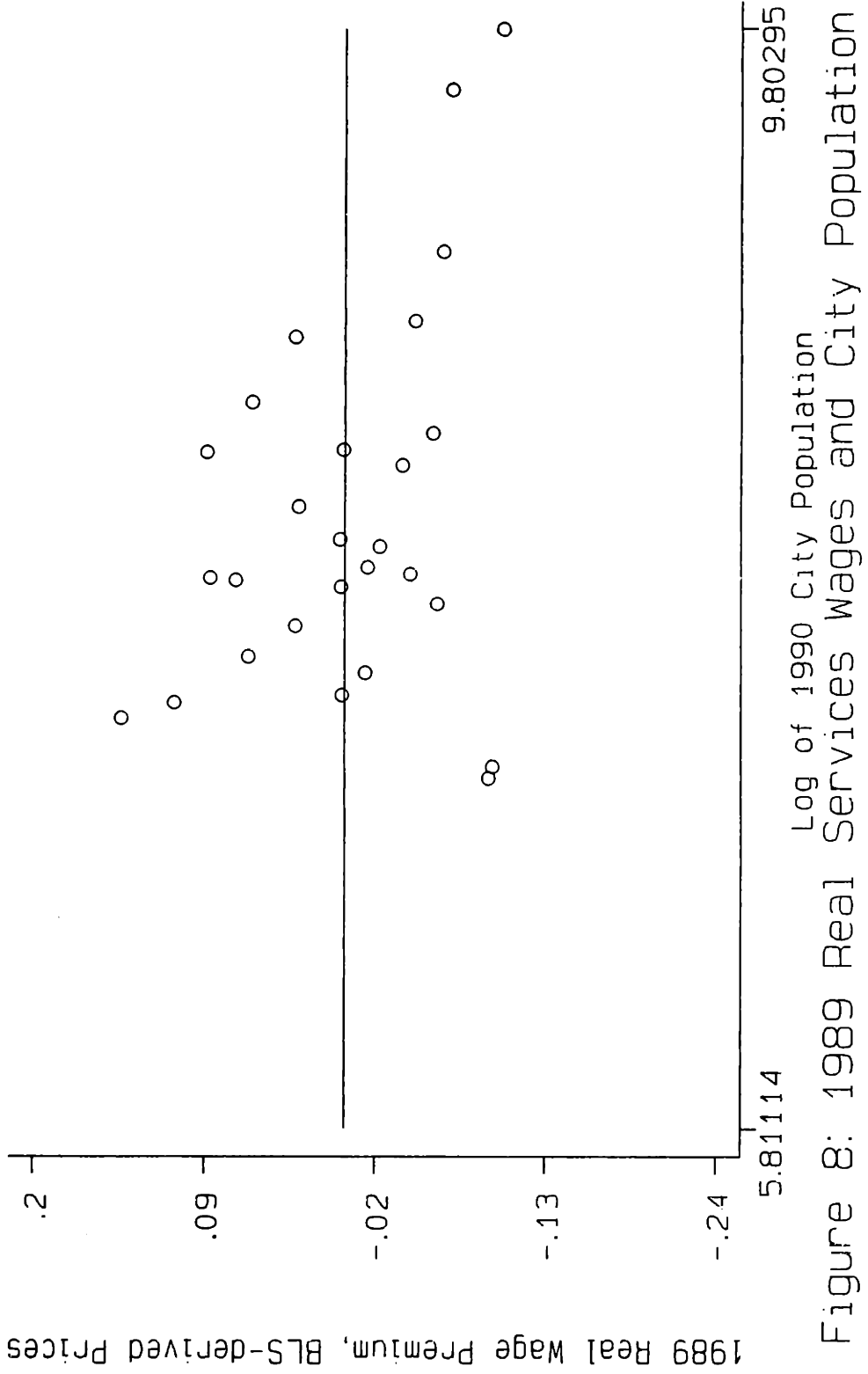


Figure 8: 1989 Real Services Wages and City Population

distance. I also allow for fixed effects associated with location near a specific hub. Starting with manufacturing, the first regression (column I) indicates that an increase in 100 miles of distance from the nearest hub is associated with a 0.8 percentage point fall in the wage premium. Note that distance is measured in units of 100 miles in Table 1. The distance coefficient is significant at the 1% level. (The standard errors in Table 1 are heteroskedasticity-robust (Huber).) As suggested by the earlier graphs, the coefficient on the population variable is positive, and significant at 5%. Column II adds the square of distance as a regressor. Distance squared has essentially zero significance. The coefficient on linear distance does not change much and remains significant.⁵ I take the evidence as supportive of a linear function in distance. I will use the linear form for the remainder of the analysis of manufacturing premia. Note that the logarithm of distance would also fit well, but this formulation makes less sense intuitively.

Columns IV-VI of Table 1 present results from the same set of regressions for services wage premia. Some differences emerge. First, the effect of linear distance is a little smaller (column IV). Second, when the square of distance term is added (V), the coefficient on linear distance changes significantly and the coefficient on the squared term is significant. Thus, a quadratic form seems warranted for services. Finally, the fixed effects have different effects in services. Cities in the New York and Los Angeles hubs have significantly higher nominal wages than cities in the Chicago hub. The fixed effects were negative for New York and Los Angeles in the manufacturing regressions, but only significant (at the 10% level) for Los Angeles.

⁵If the regressions are run with averages on the LHS instead of the yearly observations, the coefficient on linear distance becomes insignificant when the square is added. However, as noted in the text, the estimate changes little. Since linear distance and distance squared are highly correlated, there are not enough observations in the average regression to estimate their coefficients precisely.

Table 1: Nominal Wage Premia and Distance (OLS/Huber s.e.)

Dependent variable is city wage premium (in manufacturing or services). Distance is measured in units of 100 miles.

	Manuf. I	Manuf. II	Manuf. III	Services IV	Services V	Services VI
Distance to Nearest Hub	-0.0084 (0.0010)	-0.0094 (0.0035)	-----	-0.0035 (0.0008)	-0.0129 (0.0034)	-----
Distance ²	-----	0.0001 (0.0003)	-----	-----	0.0007 (0.0003)	-----
Log of Distance	-----	-----	-0.0430 (0.0045)	-----	-----	-0.0236 (0.0043)
Log of 1990 Population	0.0154 (0.0035)	0.0075 (0.0036)	0.0228 (0.0041)	0.0523 (0.0031)	0.0502 (0.0034)	0.0576 (0.0036)
NY Hub	-0.0089 (0.006)	-0.0093 (0.0061)	-0.0162 (0.0062)	0.0429 (0.0064)	0.0392 (0.0061)	0.0382 (0.0063)
LA Hub	-0.0213 (0.0120)	-0.0214 (0.0120)	-0.0212 (0.0122)	0.0535 (0.0090)	0.0520 (0.0090)	0.0551 (0.0092)
Constant	-0.0565 (0.026)	-0.0529 (0.0291)	-0.0866 (0.0294)	-0.3666 (0.0233)	-0.3312 (0.0282)	-0.3852 (0.0267)
R ²	.172	.172	.175	.409	.418	.389
Observations	594	594	576	594	594	576

The results for services imply that the marginal effect of distance is smaller for services wage premia than manufacturing. Still, when the quadratic term is included, distance in services does not begin to have a positive effect on wage premia until 1745 miles from the nearest hub.

This distance is greater than any in the sample. As noted earlier, the rationale for the distance effect is more directly related to manufactured goods than nontraded services. Distance should affect services wages through its effect on manufacturing wages. If there is some segmentation in the labor force between manufacturing and services in each location, however, it seems reasonable that distance would have a stronger effect on manufacturing wage premia. I will not speculate about the significance of the hub fixed effects for services premia.

Finally, with respect to Table 1, I note that annual regressions on manufacturing premia produce similar results. Linear distance fits well in each year, and the quadratic term adds little. The annual results for services are more mixed. In 1987 and 1988, for example, neither functional form for distance seems to work well.

In Table 2, I present some robustness checks on the effects of distance. Since the rationale for distance is most directly related to manufacturing, I confine the analysis in Table II to manufacturing wage premia.

The first column of Table 2 reports results from adding distance variables to other hubs to the specification. After controlling for distance to the nearest hub, the distance to the next closest hub and the distance to the farthest hub both have a positive and significant effect on manufacturing wage premia. The positive coefficients perhaps indicate some sort of congestion effect that makes location outside large economic centers desirable, conditional on having access to some hub. The coefficient on distance to the nearest hub does not change much from its value in the earlier regressions, and remains significant at the 1% level. The hub fixed effects are negative and significant for New York and Los Angeles. Manufacturing wages are highest in the Chicago region, conditional on everything else.

Table 2: Nominal Manufacturing Wage Premia and Distance II (OLS/Huber s.e.)
 Dependent variable is city wage premium in manufacturing. Distance is measured in units of 100 miles.

	Manuf. I	Manuf. II	Manuf. III
Distance to Nearest Hub	-0.0082 (0.0012)	-0.0095 (0.0015)	-0.0122 (0.0018)
Distance to Middle Hub	0.0029 (0.0015)	-----	0.0062 (0.0014)
Distance to Farthest Hub	0.0050 (0.0014)	-----	0.0051 (0.0013)
Log of 1990 Population	0.0127 (0.0035)	0.0167 (0.0035)	0.0132 (0.0035)
NY Hub	-0.0400 (0.0110)	-0.0082 (0.0099)	-0.0453 (0.0132)
LA Hub	-0.0811 (0.0206)	-0.0632 (0.0199)	-0.1810 (0.0258)
NY Hub * Distance		-0.0005 (0.0019)	0.0010 (0.0020)
LA Hub * Distance		0.0078 (0.0030)	0.0131 (0.0027)
Constant	-0.1678 (0.0387)	-0.0590 (0.0262)	-0.1826 (0.0375)
R ²	.194	.188	.223
Observations	594	594	594

The second column of Table 2 omits the extra distance terms and adds instead interactions on the coefficient of distance to hub with dummies for the hub in question. The results in this column indicate a weaker distance effect in the Los Angeles region. In fact, the overall effect of distance in the Los Angeles region, though negative, is not significantly different

from zero. My sample contains only 16 cities in the Los Angeles region, however, so caution is warranted in interpreting these results.

Finally, the third column of Table 2 includes the extra distance terms as well as the interactions on hub distance. The results again suggest that the Los Angeles region is different. The overall effect of distance in the Los Angeles region is not significantly different from zero; in fact, it is slightly positive. The hub fixed effects are again negative and significant and again indicate higher that Chicago has the highest manufacturing wages, conditional on everything else.

Overall, with respect to nominal manufacturing premia, the distance to hub effect seems to fit quite well across different specifications, at least for the New York and Chicago regions. There is some evidence that distance has less (or no) effect in Los Angeles, but with only 16 cities in the region, it is difficult to draw a firm conclusion. I also note that annual regressions using the specifications in Table 2 produce similar results.

I now examine the effects of distance on real wage premia. As I noted above, distance should affect real premia only to the extent that proximity to a hub is an amenity from the point of view of workers. Table 3 reproduces the regressions from Table 1 for real manufacturing and services premia, using the Chamber of Commerce price index. The regressions include year fixed effects to adjust the yearly average real premia to zero. There are three basic points to make about Table 3. First, in the quadratic functional form, real wages increase with distance, but at a decreasing rate. The point at which distance becomes a positive effect on real wages exceeds the maximum distance to hub in my sample. Second, population has a negative relationship with real manufacturing wages, but no significant effect with real services wages.

Finally, after controlling for distance and population, real manufacturing wages are highest in the Chicago region, and about the same in the other two regions. Real wages in services are lowest in the New York region.

Table 3: Average Real Wage Premia and Distance (OLS/Huber s.e.)

Dependent variable is real wage premium (in manufacturing or services). Distance is measured in units of 100 miles.

	Manuf. I	Manuf. II	Manuf. III	Services IV	Services V	Services VI
Distance to Nearest Hub	-0.0001 (0.0013)	0.0243 (0.0053)	-----	0.0038 (0.0011)	0.0245 (0.0047)	-----
Distance ²	-----	-0.0019 (0.0004)	-----	-----	-0.0016 (0.0003)	-----
Log of Distance	-----		0.0034 (0.0063)	-----	-----	0.0215 (0.0050)
Log of 1990 Population	-0.0407 (0.0067)	-0.0346 (0.0063)	-0.0301 (0.0055)	-0.0042 (0.0068)	0.0009 (0.0062)	0.0067 (0.0053)
NY Hub	-0.0668 (0.0095)	-0.0578 (0.0088)	-0.0606 (0.0091)	-0.0327 (0.0081)	-0.0251 (0.0078)	-0.0255 (0.0075)
LA Hub	-0.0850 (0.0135)	-0.0789 (0.0140)	-0.0863 (0.0135)	-0.0152 (0.0111)	-0.0100 (0.0115)	-0.0159 (0.0109)
Year Dummies	yes	yes	yes	yes	yes	yes
R ²	.288	.328	.228	.074	.123	.077
Observations	419	419	410	419	419	410

As a check on the results in Table 3, I ran the same regressions using the 1989 real wage data, constructed under alternative price indices--Chamber of Commerce and BLS-derived. In the Chamber of Commerce sample, I have more observations in 1989 than any other year. The estimates for the quadratic functional form are similar to those presented in Table 3, but the level of significance on the distance term declines. In the regressions for 1989 using the Chamber of Commerce index to construct real wages, all of the coefficients on the distance terms are significant at the 10% level, except for the manufacturing coefficient on linear distance. In the regressions for 1989 using the BLS-derived price index, only the services coefficient on linear distance is significant at the 10% level. I have only 27 observations for 1989 in the BLS-derived sample, however.

5. DISCUSSION

In the spirit of the modern economic geography models, I have investigated the relationship between distance, market size, and wage differentials across U.S. cities. I read the evidence presented in this paper as broadly consistent with the modern geography models, although certainly more could be done. One might also think about adding other sorts of variables that relate to transport costs, for example proximity to a port. In addition, a much tighter empirical specification, including meaningful tests against alternative hypotheses, will be required to draw firm conclusions.

Still, the results presented here provide preliminary evidence that distance and market size matter. These two variables account for a large fraction of the cross sectional variance of wages across cities. The implied magnitude of the distance effect in manufacturing

(1 percentage point per 100 miles) seems large enough to be interesting but not unreasonably large. In addition, the relationship between real wages and distance is intriguing. The results suggest that proximity to one of the three regional hubs is an amenity for workers. On the basis of the results presented here, further research on the distance-wage relationship seems warranted.

APPENDIX

Sample Cities and Distances to Nearest Hub:

NEW YORK REGION (34 CITIES)

<u>City</u>	<u>Distance To NY</u>
Albany, NY	156
Allentown, PA	118
Augusta, GA	792
Baltimore, MD	202
Boston, MA	219
Buffalo, NY	424
Charleston, SC	775
Charlotte, NC	625
Columbia, SC	725
Greensboro, NC	531
Harrisburg, PA	197
Hartford, CT	118
Jacksonville, FL	952
Lakeland, FL	1147
Lancaster, PA	172
Miami, FL	1293
New Haven, CT	78
New York, NY	0
Norfolk, VA	380
Orlando, FL	1092
Philadelphia, PA	121
Pittsburgh, PA	397
Providence, RI	183
Raleigh, NC	504
Richmond, VA	355
Rochester, NY	360
Scranton, PA	141
Springfield, MA	144
Syracuse, NY	269
Tampa, FL	1150
Washington, DC	423
West Palm Beach, FL	1230
Worcester, MA	180
York, PA	198

LOS ANGELES REGION (16 CITIES)

<u>City</u>	<u>Distance To LA</u>
Albuquerque, NM	804
Bakersfield, CA	112
El Paso, TX	814
Fresno, CA	215
Las Vegas, NV	275
Los Angeles, CA	0
Phoenix, AZ	381
Portland, OR	967
Sacramento, CA	387
Salt Lake City, UT	688
San Diego, CA	124
San Francisco, CA	382
Seattle, WA	1151
Spokane, WA	1210
Stockton, CA	339
Tucson, AZ	494

CHICAGO REGION (49 CITIES)

<u>City</u>	<u>Distance To Chicago</u>
Atlanta, GA	720
Austin, TX	1123
Baton Rouge, LA	919
Beaumont, TX	1103
Birmingham, AL	663
Canton, OH	393
Chattanooga, TN	601
Chicago, IL	0
Cincinnati, OH	299
Cleveland, OH	355
Colorado Springs, CO	1084
Columbus, OH	363
Corpus Christi, TX	1338
Dallas, TX	928

CHICAGO REGION (CONTINUED)

<u>City</u>	<u>Distance To Chicago</u>
Davenport, IA	175
Dayton, OH	302
Denver, CO	1014
Des Moines, IA	334
Detroit, MI	286
Flint, MI	276
Fort Wayne, IN	169
Grand Rapids, MI	183
Greenville, SC	711
Houston, TX	1085
Indianapolis, IN	185
Jackson, MS	749
Johnson City, TN	631
Kansas City, MO	530
Knoxville, TN	545
Lansing, MI	222
Little Rock, AR	655
Louisville, KY	299
Memphis, TN	536
Milwaukee, WI	92
Minneapolis, MN	409
Mobile, AL	923
Nashville, TN	474
New Orleans, LA	929
Oklahoma City, OK	791
Omaha, NE	471
Peoria, IL	170
Saginaw, MI	310
St. Louis, MO	297
San Antonio, TX	1202
Shreveport, LA	868
Toledo, OH	251
Tulsa, OK	688
Wichita, KS	720
Youngstown, OH	411

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