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Abstract

We develop an international general equilibrium economic model for explaining urban apartment rents. We present statistical evidence, perhaps for the first time, of the impact of international economic openness on residential real estate, consistent with the well-known Balassa-Samuelson effect. A higher level of economic openness affects residential real estate by increasing demand for consumption goods (the tradable sector) and housing (the non-tradable sector), with the rents in the latter impacted disproportionately because of the relatively inelastic supply. Using principal components regression analysis and a dataset of 55 cities in different countries, our analysis explains residential rents, controlling for a number of factors, such as urban wages, city size and location. Our primary statistical findings are that urban rents are positively affected by the openness of the economy, by city size and the ratio of the city to total country population.

Keywords: globalization, real estate, housing, openness, Balassa-Samuelson effect

JEL Classification Number: R10, R20, R31, F10, F40

1 Introduction and Motivation

Surprisingly, in an era of enhanced globalization, the academic literature on international trade and urban real estate economics co-exist in virtually isolated arenas, with rare contact, connections or cross-references. International trade, capital flows and transnational investments have been growing at a rapid pace. Cross-border investments in real estate, international development projects, multinational real estate ventures and even housing developments are expanding briskly, causing one of the most "non-tradable" (in the sense of not being exportable or importable) sectors to be globalized. In this paper, we explore, to our knowledge for the first time, a transmission mechanism from economic openness and international trading activity to the real estate sector. Although this channel or impact has long been intimated in international economics theory, under the rubric of the "Balassa-Samuelson" effect, its existence in the real estate sector has never been confirmed empirically. According to this view, increasing openness of national economies should cause the relative price of non-tradables, (in our case, real estate property/rents) to increase vis-à-vis that of traded goods. Economic intuition suggests that with increasing openness and globalization, the traded sectors experience a greater increase in productivity, because of greater market size, learning effects and changes in technology, and smaller increases in prices relative to the non-traded goods. Additionally, a positive demand shock, say, through an increase in wages, would have a greater inflationary impact on non-tradables, since the supply of non-tradables is relatively inelastic, whereas a small open economy could presumably import a traded good at will from the rest of the world with a minimal effect on price.

Our objective is to explore the determinants of residential rents for 55 major world cities, and to examine how economic openness affects them, after controlling for local and standard urban real estate economic variables. The inclusion of the novel openness variable in our statistical analysis is a test for the Balassa-Samuelson effect in the housing sector.

1.1 A Selective Literature Review

The Balassa-Samuelson effect has a distinguished pedigree in international economics. The literature has concentrated on the study of relative prices of non-traded goods as a hypothetical aggregate good. This strand of literature has focused on the relationship among real exchange rates, international purchasing power and economic openness, usually seen in the context of traded and non-traded goods as aggregated goods and services.

Using 1970-1985 sectoral data for the OECD countries, De Gregorio et al (1994) show that inflation in non-tradable goods exceeds inflation in tradables. Their contention is that growth in total factor productivity in the tradable goods sector and a demand shift in favor of non-tradables are the major determinants of the differential price rise. In an alternative yet related tack, DeLoach et al (2001) provide evidence of a statistically significant, long-run, positive relationship between the relative price of non-tradables and real output, and, therefore, is consistent with the notion of relative productivity increases in the tradable sector, hypothesized by Balassa and Samuelson. That is, increases in productivity in the traded goods sector due to increased global economic integration lead to a traded-goods sector led growth in output, and a concomitant rise in relative prices of non-tradables.

While prices of traded goods are expected to equalize across countries, there is some evidence that prices for non-traded goods may tend to equalize for sets of countries that are large trading partners, or geographically close. For example, Aten (1997) shows that non-tradable price differences of significant trading partners can be captured by geographic proximity. "Distance" is more strongly associated with countries' relative prices than the extent of trade between them; but for given income levels, countries that are strong trading partners will have more similar prices, even for non-tradable goods. This finding is not necessarily inconsistent with the effects on a national economy of "general openness" to the rest of the world.

Our paper is also indirectly related to the work of Ades and Glaeser (1995) and Krugman and Livas-Elizondo(1996). These are among a handful of papers that link urban economics, and international economics and trade policy. The former, an empirical study, includes case studies, and avers that high tariffs and low levels of international trade (i.e., countries with a low level of economic openness) increase the degree of concentration of a nation's population in the largest city. The latter paper, a theoretical model, explains why the "..giant third world metropolis is an unintended byproduct of import-substitution policies and will tend to shrink as developing countries liberalize...." The intuition is that strong forward and backward domestic economic linkages arise in a small market, leading to this kind of agglomeration; increasing openness would increase market size and weaken these linkages, and hence the raison d'etre for size clustering. In a later section, we discuss the relationship between this literature and our own model and estimation procedure involving city size, thus providing an intellectual link between urban economics, real estate economics and international economics.[1]

Asea and Mendoza (1994), Rebelo (1997), Strauss (1999), Falvey and Gemmel (1999) provide additional theoretical and empirical support for the economic interplay of productivity differentials, exchange rates, exogenous shocks, purchasing power parity and relative prices of specific non-tradable goods and services. However, to the best of our knowledge, prior research has not focussed upon real estate pricing and its relationship to both domestic and international variables, despite the fact that real estate is the major asset component of the non-tradable sector.

2 A Simple Model

In this section, we develop a simple theoretical model that enables us to show that openness, in terms of trade in intermediate products, is a determinant of residential rents. Trade in intermediate inputs is a defining feature of the present stage of globalization. The idea that the price of non-tradables (e.g. housing) is related to the openness of the economy, as mentioned before, is

[1] The earlier research of Isard (1956) and Anas, Arnott and Small (1998), among others, deals with a related subject area, the interplay between the dynamics of urban structure and economic forces. Similarly, the fractal dimension literature, characterized by Batty and Longley (1994), bears upon our analysis, but is beyond the scope of the current paper.

not new.[2] The traditional Ricardian model provides us a simple rationale; the price of non-traded goods is determined by local technology (i.e. productivity) of non-traded goods (the supply side effect) and the prices of traded goods through the wage rate, which is a function of the productivity of traded goods, and which is a demand side effect.

We now present a schematic model, that (1) embeds these insights in a dynamic general equilibrium, where the stocks of capital and the residential housing, instead of being fixed, as in some static models, will be endogenously determined; the labor supply and the intertemporal saving/investment decisions will be simultaneously optimized, and (2) leads us to *an estimation procedure* for metropolitan rents as a function of openness, as well as providing appropriate control variables. The key model innovations are the inclusion of imported inputs as a component in the production function to reflect an increasing aspect of globalization, and the use of a variable that proxies for city size. The latter variables permit us to relate our work to the urban economics based strand of literature typified by Ades and Glaeser (1995) and others mentioned above.

Our model is a variant of Rebelo (1991), and Greenwood and Hercowitz

[2] The literature is too large to be surveyed here. See Jones (1979, 2000) and the reference therein.

(1991), with residential property introduced in the utility function.[3] Time is discrete in this model and the horizon is infinite. The "small open economy" is populated by a continuum of infinite-lived agents. The population is $\mathcal{N}$, which is fixed over time. In each period t, $t = 1, 2, 3, \ldots$, the representative agent derives utility $u(C_t, H_t + H_t^r, L_t)$ from non-durable consumption goods C_t , the stock of housing (or residential property)[4] owned by the agent H_t, and the amount of housing rented from the market H_t^r, as well as the amount of leisure enjoyed L_t, $0 \leq L_t \leq 1$. H_t is broadly defined to include the residential structure, as well as the associated amenities. Following Greenwood and Hercowitz (1991), it is assumed that

$$u(C_t, H_t + H_t^r, L_t) = \ln C_t + \omega_1 \ln (H_t + H_t^r) + \omega_2 \ln (L_t), \qquad (1)$$

where ω_1, $\omega_2 > 0$. The representative agent is assumed to maximize the life time utility $\sum_{t=0}^{\infty} \beta^t u(C_t,\ H_t + H_t^r, L_t)$, participate in the production of consumption goods C_t, and accumulate business capital stock K_t, and residential property H_t. β is the time discount factor, $0 < \beta < 1$.[5]

[3]See Kwong and Leung (2000), Leung (2001) for related studies.

[4]In this paper, "housing" and "residential capital" will be used interchangeably.

[5]See Stokey, Lucas and Prescott (1989, esp. chapter 3) for more discussion on the role of the time discount factor.

The representative agent is a price taker in all industries and he/she is subject to a series of constraints. (For notational convenience, time subscripts are suppressed unless there is a risk of confusion). First, the total value of non-durable consumption C, and investment in business capital, residential property, I_k, I_h respectively,[6] expenditures on raw materials imported from the "outside world" PM (where P is the unit price of imported material and M is the amount of raw material imported), expenditure on the residential property purchased from the market, $Q_h H^m$, and the expenditure on renting housing from the market $R_h H^r$, cannot exceed the total value of production $Y \equiv A\,(K)^{\Theta_1}\,(\mathcal{N}(1-L))^{\Theta_2}\,(M)^{1-\Theta_1-\Theta_2}$, $A > 0$, $0 < \Theta_1, \Theta_2 < 1$.

Several assumptions are implicitly made in this formulation. First, the consumption good produced is the numeraire, and the imports from the rest of the world by the "small open economy" are always available for any amount at the prevailing world price. Therefore, the unit price of input P is a relative price (or, the "terms of trade") and it is treated as exogenous. In this simple model, P is the effective price of imported goods, including the tariff, quota and other trade restrictions, if any, and can be viewed as a measure of "openness". On the other hand, the relative price of residential

[6] Residential investment I_h includes maintenance, renovation, purchase of new furniture, appliance, etc. Analogous interpretation applies to I_k as well.

property, Q_h , and the housing rent R_h, are determined endogenously.

Whether it pays to invest or where to invest depends crucially on the payoff of the investment. Following Hercowitz and Sampson (1991) and Benassy (1995), if we assume a specific form of law of motion for different types of capital, we will obtain closed forms of the solution,[7]

$$K_{t+1} = B_k (K_t)^{1-\delta_k} (I_{kt})^{\delta_k}, \quad (2)$$

$$H_{t+1} = B_h (H_t + H_t^m)^{1-\delta_h} (I_{ht})^{\delta_h}, \quad (3)$$

where B_k, $B_h > 0$, $0 < \delta_k$, $\delta_h < 1$. Housing rented in the current period H_t^r does not contribute to the future residential capital H_{t+1}, but only H_t^m does. The dynamic programming problem of the representative agent is now:

$$V(K_t, H_t) = \max . u(C_t, H_t + H_t^r, L_t) + \beta V(K_{t+1}, H_{t+1}) \quad (4)$$

$$\text{s.t. } Y_t \geq I_{kt} + I_{ht} + C_t + P_t M_t + Q_{ht} H_t^m + R_{ht} H_t^r, \quad (5)$$

$$\text{where } Y_t = A (K_t)^{\Theta_1} (\mathcal{N}(1 - L_t))^{\Theta_2} (M_t)^{1-\Theta_1-\Theta_2}. \quad (6)$$

[7]An alternative approach is to adopt a more general framework and then use loglinearization as in Campbell (1994). The reduced forms of the dynamics, however, would be similar. See Lau (2002).

Also, equations (2) and (3) are still in force. It is implicitly assumed in (5) that the representative agent *observes* the current period productivity A_t *first, and then decides* how much raw materials are to be imported from the "rest of the world", given the amount of capital and property the representative agent owns. In the appendix, we show that the problem can be simplified and prove the following proposition:

Proposition 1 *In this model economy, if*

$$\beta\theta_1\delta_k\left(1-\beta\left(1-\delta_k\right)\right)^{-1}<1,$$

the amount of working hours are fixed and the consumption and different kinds of investment are all a fixed share of the output,

$$L_t = L,\ C_t = \Pi_c Y_t,\ I_{j,t} = \Pi_j Y_t,\ j = k,\ h, \tag{7}$$

With reasonable market-clearing conditions imposed on the structure, this proposition enables us to characterize the equilibrium quantities (and prices) *in each period* as functions of exogenous variables. In other words, we can trace the evolution of the whole system.

Rewriting our variables in log form, then, $\theta_y = \ln \Theta_0$, $\eta_j = \ln \Pi_j$, $j = c$, k, h, $c_t = \ln C_t$, $y_t = \ln Y_t$, etc. The economy is hence represented by the following *linear* equations:

$$y_t = \theta_y + \theta_A a + \theta_1 k_t - \theta_2 p_t + (1 - \theta_1) n^*, \tag{8}$$

$$\begin{aligned} k_{t+1} &= b_k + (1 - \delta_k)\, k_t + \delta_k i_{kt}, \\ h_{t+1} &= b_h + (1 - \delta_h)\, h_t + \delta_h i_{ht}, \end{aligned} \begin{aligned} (9) \\ (10) \end{aligned}$$

$$\begin{aligned} c_t &= \eta_c + y_t, \\ i_{kt} &= \eta_k + y_t, \\ i_{ht} &= \eta_h + y_t, \end{aligned} \begin{aligned} (11) \\ (12) \\ (13) \end{aligned}$$

where $n^* = \ln(\mathcal{N}(1 - L^*))$, for some constants θ_y, and given the initial conditions a_0, k_0, h_0. In the appendix, we also show that

$$\begin{aligned} q_{ht} &= \theta_q + i_{ht} - h_t, \\ r_{ht} &= \theta_r + c_t - h_t, \end{aligned} \tag{14}$$

for some constants θ_q, θ_r.

With these equations, it is possible to derive several testable implications of the model.

Proposition 2 *The equilibrium rent can be written as a function of other variables,*

$$\begin{aligned} r_{ht} &= \theta_r' + y_t - h_t, \\ &= \theta_r'' + \theta_1 a + \theta_1 k_t + (1-\theta_1)n^* - \theta_2 p_t - h_t, \\ &= \theta_r''' + w_t + n^* - h_t, \end{aligned} \tag{15}$$

for some constant θ_r', θ_r'', θ_r'''.

The first two equations from (15) signify that the residential rent is positively correlated to the aggregate output y_t, the stock of business capital

k_t, the total amount of effective labor n^*, and negatively related to the import prices p_t and the stock of residential housing h_t. The third expression implies that the residential rents should be positively related to the wage rate and the total amount of effective labor, but negatively related to the stock of the residential property. The labor size variable as suggested by the urban economics literature referred to earlier implies that a is an increasing function of n, the population size. This would strengthen the argument that rents should be positively related to total effective labor inputs, which can be approximated by the population and, in our empirical analysis, by city size.

In summary, the underlying intuition of the model is simple. With more openness to trade, the small open economy attains a higher level of (per capita) income. Since housing is a normal good, the demand for housing increases. With a relatively inelastic elastic supply of housing (relative to the perfectly elastic supply of importables for a small open economy) the increase in demand increases residential rents. The next section employs a cross-country urban data-set to test the empirical validity of these theoretical conclusions.

3 Data and Empirical Results

For the year 2000, for a cross-section of 55 international cities, we have assembled data for residential rents, wages, openness, city population, as well as other related variables. The data employed in our study have been collected from a variety of sources. They are as follows:

a) *Global metropolitan residential rents*: The United Bank of Switzerland (UBS) research group has created a unique international data source. This database generates international comparisons of purchasing power aimed at the business executive community belonging to multinational corporations, who need the data for cost of living adjustments and compensation purposes. The publication, called "Prices and Earnings Around the Globe", 2000, contains data for residential rents and other variables for 55 major world cities, on five continents, and in all the major countries and is based on comprehensive surveys. Great effort and care is taken, including qualitative and other adjustments, to ensure accuracy of the data. The data is in nominal US dollars for the year 2000.

b) *Urban Wages and Price of Services*: These data have also been provided by UBS. The hourly urban wage and the monthly price for a basket of standardized local services, including haircuts, restaurant visits, auto servicing and the like, are both computed in nominal US dollars.

c) *Gross Domestic Product and Gross Domestic Product per capita*: Data for these variables are obtained from the selective query segment of the World Development Indicators database of the World Bank at http://devdata.worldbank.org /data-query. These data are in nominal US dollars.

d) *City population*[8]: These data are acquired from various sources on the World Wide Web, including http://www.citypopulation.de, as well as the United Nations statistical database. The coastal attributes of cities were elicited from http://www.worldatlas.com. Urbanization rate is available from the World Development Indicators database of the World Bank.

e) *Openness measures*: We use the standard openness indicators maintained by the National Bureau of Economic Research (NBER). This measure is calculated as the ratio of exports plus imports to the Gross Domestic Product.

We recognize two issues of concern regarding the data. First, there is a general lack of availability of reliable and comparable time-series and cross-sectional data for global metro real estate rents or prices. Second, most international economics and trade related data are collected at the national

[8]The population data is for the larger metropolitan area, rather than the administrative urban unit.

not urban level. However, as argued by Ades and Glaeser, and others, cities are manifestations of national policies, and there should be a close correlation between city and country level data. We carry out robustness and sensitivity tests, as well as other stratagems to deal with these and other issues.

Table 1 presents summary statistics for key variables; and Table 2 contains the sample correlations.

As Table 1 shows, our sample of cities is diverse, with substantial variation across cities for practically all variables (i.e., examine the standard deviations relative to the means). The monthly apartment rents range from a maximum of $1690 for Tokyo to a minimum of $100 for Bangkok. Tokyo is the largest metropolitan area in our sample (30 million), with Luxembourg (0.12 million) bringing up the rear. In terms of city size as a proportion of country population, the "metro-nations" of Singapore and Hong Kong are at one end of the spectrum, with Tel Aviv being nearly 45% of Israel's population, close behind. Not surprisingly, cities such as Mumbai (India) and Shanghai (China) have among the lowest shares as a proportion of their country's population. Singapore and Hong Kong are the most open economies.

The former's exports and imports are three and a half times its GDP; for the latter the ratio is two and a half times its GDP. At the other end of the scale, Russia, Brazil and India are clustered close together with a range for openness between 15 to 18%.

In Table 2, as expected from earlier Alonso-Muth-Mills urban analyses, rent is positively correlated with the urban wage, and is also positively correlated with the population. Similarly, we find that rents are positively correlated with openness and the city share of country population. The last variable has a very high correlation with openness, which is contrary to the position of Ades and Glaeser (1995) that increased openness tends to decrease urban concentration in the largest city. Even when Singapore and Hong Kong are omitted from the sample, the correlation between the city population share and openness is about 0.4. Of course, correlations are suggestive, not definitive models of causality; moreover, the Ades-Glaeser "story" takes into account a number of other policy and political factors, and their sample has a much larger representation from the developing world.

A possible concern with our empirical analysis is that the control variables may be highly correlated with each other as well as with openness. In fact, for our sample, GDP per capita, cost of living as expressed in urban prices of services, urbanization rate (share of country population that is urban) and wages are all highly correlated with each other, and with openness. These variables, which are likely to be important determinants of the demand for real estate, are also a measure of general economic development, and have an impact on rents as well. We use principal component regression analysis to address multicollinearity among GDP per capita, the urban wages, the urbanization rate and our cost of living proxy.[9] We capture most of the variation among these variables in the form of an index, the first principal component, which we shall dub "Income". Since none of the variables forming the principal component is our primary object of interest, this is a convenient method to overcome multicollinearity.

The first principal component is a linear combination of the following four variables, with weights corresponding to the first eigenvector:

$$\begin{aligned} \textit{Income} &= 0.41\ \textit{(GDP per capita)} + 0.42\ \textit{(Hourly wages)} \\ &+ 0.40\ \textit{(price of services)} + 0.39\ \textit{(Urbanization rate)} \end{aligned}$$

The variance proportion explained by this first principal component is 88%, and is given by the share of the eigenvalue corresponding to this com-

[9] Principal component method has been widely used in economics and other areas. Among others, see Timm (2002) for a textbook treatment.

ponent (3.52) in the sum of all four eigenvalues (4). We use this index, or Income variable, as one of the regressors in our estimation model.

3.1 Empirical Results

Table 3 contains our statistical results for explaining global metro city rents. The first equation in Table 3 is the OLS estimate for rents as a function of Income (the principal component), city population and the NBER measure of openness. The latter two variables emerge from our theoretical model as key determinants of urban rents, whereas the Income variable controls for a number of demand side factors.

The coefficients on all these variables are positive, including the coefficient on openness, buttressing our hypothesis about the impact of openness on residential rents. The coefficient of the principal component, the index of economic development and income, which is an increasing linear function of urbanization, wages, local service prices and overall country level incomes per capita, is positive and significant. The interpretation is straightforward: higher economic development tends to generate higher rents through an increase in demand. The coefficient on the city population variable is also positive and significant, lending support to an agglomeration effect hypothesis, as well as perhaps the Alonso-Muth transportation costs view.[10] Finally, after controlling for economic development and city size, the positive and significant coefficient for the openness variable supports the Balassa-Samuelson hypothesis that prices of non-tradables (i.e. metro rents) are affected by openness. In equation 2, we modify the independent variable mix by using the share of the city in total country population instead of the city population variable, as well as controlling for the scale of the economy, by including total country GDP. We find that the larger the ratio of the city population to total country population (i.e. city share), the higher the residential rents; otherwise the results are similar to equation 1.

While the principal component addresses multicollinearity problems, we also should consider the possibility of endogeneity among the economic development variables, which are likely to be simultaneously determined with economic openness of an economy. Hence, we utilize an instrumental variable estimation procedure for equation 3. The ideal instrument would be correlated with openness, but is itself exogenous, and not correlated with the

[10]See Alonso (1964), Muth (1969).

error term. Fortunately, a geographic attribute of the cities –city location– fulfils this requirement. We use a dummy for coastal cities.[11] The overall fit for equation 3, vis-à-vis equations 1 and 2 is reduced; both city share and openness are statistically significant at the 10% level of confidence and all the signs on the coefficients are appropriate. In sum, for all three regression equations, openness appears to increase residential real estate rents, as anticipated by the theory.

Table 4 shows our robustness tests. Hong Kong and Singapore are outliers both in terms of openness and the city population share variables. We re-estimate equations 2 and 3 (from Table 3), after excluding Hong Kong and Singapore from the sample. Openness remains significant in both the specifications, albeit at the 10% level. While it is clear that the results in Table 4 are diminished in statistical significance, given the data limitations and our diverse, heterogeneous sample, the "fit" is impressive and the individual coefficients are well-behaved.[12]

[11] The dummy variable is equal to one if a coastal city and zero otherwise. This approach is simple and also helps pre-empt the critique that our openness data is gathered not at the metro but at the national level.

We tested an alternative, i.e. the distance to the coast. However, this approach creates a number of problems with respect to the "chosen" coast. Should it be the nearest one, or should distance be measured to the nearest seaport, etc.

[12] We also employed in our statistical model other measures of openness, such as the one developed by Gwartney et al, which takes tariff barriers as well as other variables into account; the basic statistical results do not change.

Our explanatory variables integrate the conceptual models, as it were, of three disciplines. Real estate economics suggests the use of an overall demand measure - the principal component index of "Income"; urban economics indicates we should include measures of city size and city share; and international economics proffers the inclusion of the openness variable. Our results suggest that each of these disciplines, individually and collectively, are needed for explaining urban rents.

4 Concluding Remarks

In this paper, we explore the determinants of global metro residential rents, while also testing empirically for evidence of the Balassa-Samuelson effect in international real estate. The effect, hypothesized in international economics, suggests that the more open an economy, the higher the relative prices of non-tradable goods and services (including real estate) should be, due to both increasing productivity in the traded goods and services sectors because of openness, trade and competition, and the relatively inelastic supply of non-traded goods and services.

We develop an empirically testable model that controls for urban size and structure, as well as standard real estate economics variables, while testing for the effect of economic openness. Using imported inputs in the production function, with output being used for housing investment, as well as having housing in the utility function, our theoretical model generates the conclusion that residential rents are an increasing function of openness, income and city size.

For a cross-section of 55 major world cities, we estimate the determinants of global urban apartment rents. Our empirical work uses data assembled from a number of sources and develops a principal component index to capture correlated demand variables. Our statistical results confirm the impact of international economic openness on urban residential rents.[13] Rents are impacted positively by openness as well as by city size and city share in country's population. In addition to the use of a principal component income index as a regressor, we also employ instrumental variable estimation

[13]We choose rents rather than prices for two reasons. First, we are constrained by data availability and reliability. Second, previous studies such as Clark (1995), among others, show that the long run rent-price relation does satisfy the prediction of the present value model, and hence focusing on rent may not be distorting.

to address the possibility of endogeneity in our independent variables. For purposes of a robustness test we reestimate our regressions with a truncated sample, removing potential outliers.

We believe there is a potential for further research, by integrating concepts of international economics and urban/real estate economics, and of tradables and non-tradables. We hope better, more extensive, pooled time-series and cross-sectional data would be used to further explore our preliminary findings that openness is a key determinant of urban residential rents around the world.

References

[1] Ades, Alberto and Edward Glaeser (1995), "Trade and Circuses: Explaining Urban Giants," *Quarterly Journal of Economics,* 110(1), 195-227.

[2] Ades, Alberto and Edward Glaeser (1999), "Evidence on Growth, Increasing Returns, and the Extent of the Market," *Quarterly Journal of Economics*, 114(3), 1025-45.

[3] Alonso, William (1964), **Location and Land Use**, Cambridge: Harvard University Press.

[4] Anas, Alex; Richard Arnott and Kenneth Small (1998), "Urban Spatial Structure," *Journal of Economic Literature*, 36(3): 1426-64.

[5] Asea, Patrick and Enrique Mendoza (1994), "The Balassa-Samuelson Model: A General-Equilibrium Appraisal," *Review of International Economics*, 2(3), 244-67.

[6] Aten, Bettina (1997), "Does Space Matter? International Comparisons of the Prices of Tradables and Nontradables," *International Regional Science Review*, 20(1-2), 35-52.

[7] Batty, Michael and Paul Longley (1994), **Fractal Cities: A Geometry of Form and Function**, London: Academic Press.

[8] Benassy, Jean-Pascal (1995), "Money and wage contracts in an optimizing model of the business cycle," *Journal of Monetary Economics*, 35, 303-315.

[9] Campbell, John. (1994), "Inspecting the Mechanism: An Analytical Approach to the Stochastic Growth Model," *Journal of Monetary Economics*, 33, 463-506.

[10] Case, Bradford; William Goetzmann and Geert Rouwenhorst (1999), "Global Real Estate Markets: Cycles and Fundamentals," Yale School of Management, WP ICF 99-03.

[11] Clark, Todd (1995) "Rents and Prices of Housing across Areas of the United States: A Cross-Section Examination of the Present Value Model," *Regional Science and Urban Economics*, 25(2), 237-47.

[12] De Gregorio, Jose, Alberto Giovannini, Holger Wolf, Robert Gordon, and others (1994), "International evidence on tradables and nontradables inflation: Comments." *European Economic Review*, 38(6), 1225-1256.

[13] DeLoach, Stephen (2001), "More Evidence in Favor of the Balassa-Samuelson Hypothesis," *Review of International Economics*, 9(2), 336-42.

[14] Easterly, William; Robert King, Ross Levine and Sergio Rebelo (1993) "Policy, Technology Adoption and Growth," in Robert Solow and Luigi Pasinetti (ed.), **Economic Growth and the Structure of Long Term Development**, New York: International Economic Association.

[15] Falvey, Rod and Norman Gemmell (1999), "Factor endowments, nontradables prices and measures of 'openness'," *Journal of Development Economics*, 58 (1), 101-122.

[16] Gort, Michael, Jeremy Greenwood and Peter Rupert (1999) "Measuring the rate of technological change in structures," *Review of Economic Dynamics*, 2, 207-30.

[17] Greenwood, Jeremy and Zvi Hercowitz (1991) "The allocation of capital and time over the business cycle," *Journal of Political Economy*, 99, 1188-1214.

[18] Gwartney, Jim and Robert Lawson with Walter Park and Charles Skipton. Economic Freedom of the World: 2001 Annual Report. Vancouver: The Fraser Institute, 2001. Data retrieved from http://www.freetheworld.com.

[19] Hercowitz, Zvi and Michael Sampson (1991), "Output, growth, the real wage, and employment fluctuations," *American Economic Review*, 81, 1215-37.

[20] Isard, Walter (1956), **Location and Space-Economy : A General Theory Relating to Industrial Location, Market Areas, Land Use, Trade, and Urban Structure**, Cambridge: MIT Press.

[21] Jones, Ronald (1979), **International Trade : Essays in Theory,** New York: North-Holland.

[22] Jones, Ronald (2000), **Globalization and the Theory of Input Trade**, Cambridge: MIT Press.

[23] Krugman, Paul and Raul Livas Elizondo (1996), "Trade Policy and the Third World Metropolis," *Journal of Development Economics*, 49(1), 137-50.

[24] Kwong, Sunny Kai Sun and Charles Ka Yui Leung (2000), "Price volatility of commercial and residential property," *Journal of Real Estate Finance and Economics*, 20(1), 25-36.

[25] Lau, Sau-Him Paul (2002). "Further inspection of the stochastic growth model by an analytical approach," *Macroeconomic Dynamics*, 6, 748-757.

[26] Leung, Charles Ka Yui (2001), "Relating international trade to the housing market," *Review of Development Economics*, 5(2), 328-35.

[27] Ljungqvist, Lars and Thomas Sargent (2000), **Recursive Macroeconomic Theory**, Cambridge: MIT Press.

[28] Lucas, Robert (1978), "Asset Prices in an exchange economy" *Econometrica*, 46, 1426-45.

[29] Muth, Richard (1969), **Cities and Housing: the Spatial Pattern of Urban Residential Land Use**, Chicago: University of Chicago Press.

[30] Rebelo, Sergio (1991), "Long-Run policy analysis and long- run growth," *Journal of Political Economy*, 99, 500-21.

[31] Rebelo, Sergio (1997), "What Happens When Countries Peg Their Exchange Rates? (The Real Side of Monetary Reforms)," *Centre for Economic Policy Research, Discussion Paper* 1692.

[32] Stokey, Nancy; Robert Lucas and Edward Prescott (1989), **Recursive Methods in Economic Dynamics**, Cambridge: Harvard University Press.

[33] Strauss, Jack (1999), "Productivity Differentials, the Relative Price of Non-tradables and Real Exchange Rates," *Journal of International Money and Finance*, 18(3), 383-409.

[34] Timm,Neil (2002), **Applied Multivariate Analysis**, New York: Springer.

[35] UBS (2000), "Prices and Earnings Around the Globe", http://www.ubs.com/e/index/about/research/publications.Referenz19.pdf.

[36] United Nations Human Development Reports: http://hdr.undp.org/statistics/default.cfm

[37] World Development Indicators: http://www.worldbank.org/data/wdi2002/index.htm

Appendix

(**Note for the editors:** In case it is decided that the appendix need not be published, it will be available upon request)

A Proofs

A.1 Proof of (7)

To prove (7), we need to first simplify the maximization problem of the representative agent. Following Easterly et. al. (1993), the amount of raw materials to purchase is a static choice. It is easy to derive the optimality condition for the raw material,

$$M_t = (1 - \Theta_1 - \Theta_2) Y_t / P_t, \tag{16}$$

$\forall t$. (6) can be re-written in terms of the input price as

$$\begin{aligned} Y_t &= A_t (K_t)^{\Theta_1} (\mathcal{N}(1 - L_t))^{\Theta_2} (M_t)^{1-\Theta_1-\Theta_2} \\ &= \Theta_0 (A_t)^{\theta_A} (K_t)^{\theta_1} (P_t)^{-\theta_2} (\mathcal{N}(1 - L_t))^{1-\theta_1}, \end{aligned} \tag{17}$$

where $\Theta_0 = (1 - \Theta_1 - \Theta_2)^{(1-\Theta_1-\Theta_2)/(\Theta_1+\Theta_2)} > 0$, $\theta_A = 1/(\Theta_1 + \Theta_2)$, $\theta_1 = \Theta_1/(\Theta_1 + \Theta_2)$, $\theta_2 = (1 - \Theta_1 - \Theta_2)/(\Theta_1 + \Theta_2)$. Hence, with (2) and (17), the maximization problem of the representative agent can be re-written as maximizing (4), subject to a revised budget,

$$Y_t \geq I_{kt} + I_{ht} + C_t + Q_{ht} H_t^m + R_{ht} H_t^r, \tag{18}$$

and (2), (3).

Now we need to derive the first order conditions of the representative agent. Let λ_{1t}, λ_{2t}, λ_{3t} be the Lagrangian multipliers of the constraints (18) and (2), (3) respectively. The first order conditions are standard:

$$\lambda_{1t} = (C_t)^{-1}, \tag{19}$$

$$\omega_2 (L_t)^{-1} = \lambda_{1t} (1-\theta_1)(Y_t/(1-L_t)), \tag{20}$$

$$\lambda_{2t} = \beta \left[\lambda_{1,t+1}\theta_1 \left(\frac{Y_{t+1}}{K_{t+1}} \right) + \lambda_{2,t+1} (1-\delta_k) \left(\frac{K_{t+2}}{K_{t+1}} \right) \right], \tag{21}$$

$$\lambda_{1t} = \lambda_{2,t} (\delta_k) (K_{t+1}/I_{kt}), \tag{22}$$

$$Q_{ht}\lambda_{1t} = \lambda_{3t} (1-\delta_h) \left(H_{t+1}/ \left(H_t + H_t^0 \right) \right), \tag{23}$$

$$\lambda_{3t} = \beta \left[\left(\frac{\omega_1}{H_{t+1} + H_{t+1}^r} \right) + \lambda_{3,t+1} (1-\delta_h) \left(\frac{H_{t+2}}{(H_{t+1} + H_{t+1}^m)} \right) \right] \tag{24}$$

$$\lambda_{1t} = \lambda_{3t} (\delta_h) (H_{t+1}/I_{ht}) \tag{25}$$

To solve this system of equations, market clearing conditions **need** to be imposed. As in Lucas (1978), in an economy with a representative agent model, there is no net trade among agents whether in the purchase market or in the rental market with perfect foresight. Thus, without loss of generality, we can assume that

$$H_t^m = H_t^r = 0, \ \forall t. \tag{26}$$

This further simplifies the first order conditions. We then need to prove the constancy of labor supply, consumption and investment of output. We would need to re-organize the first order conditions even further and we start with (20). Re-arranging the terms, we have

$$L_t = \frac{\omega_2}{\omega_2 + (1-\theta_1)(Y_t/C_t)}. \tag{27}$$

Thus, if the consumption share of output is constant, L_t will also be a constant. And from (19), (23) and (25), we have

$$Q_{ht} = \left(\frac{1-\delta_h}{\delta_h} \right) \frac{I_{ht}}{H_t},$$

$$R_{ht} = \omega_1 \left(\frac{C_t}{H_t} \right). \tag{28}$$

These expressions deliver the message that to solve for the equilibrium prices, it is necessary to solve for the equilibrium dynamics of quantities.

Our conjecture is that the consumption and investment shares are constant over time,

$$C_t = \Pi_c Y_t,\ I_{j,t} = \Pi_j Y_t,\ j = k,\ h,$$

where Π_i are all constants. Following Ljungqvist and Sargent (2000), we would impose these conjectures into the system of first order conditions and then solve these shares explicitly. If they are indeed constant, then it verifies our conjectures. We want to show first the constancy of business capital investment. Starting with (19), (21), we have

$$\lambda_{2t} K_{t+1} = \beta\theta_1 (\Pi_c)^{-1} + \beta (1 - \delta_k) \lambda_{2,t+1} K_{t+2}.$$

With the no-bubble condition

$$\lim_{t\to\infty} \beta^t \lambda_{2t} K_{t+1} = 0,$$

it is simplified as

$$\lambda_{2t} K_{t+1} = \beta\theta_1 (\Pi_c)^{-1} (1 - \beta (1 - \delta_k))^{-1}.$$

Combining it with the conjecture and (22) that

$$\lambda_{2t} K_{t+1} = (\Pi_k / \Pi_c) (\delta_k)^{-1},$$

we have

$$\Pi_k = \beta\theta_1 \delta_k (1 - \beta (1 - \delta_k))^{-1}, \tag{29}$$

which is a positive constant. And by the assumption asserted, it is strictly in between 0 and 1. So, we **have proved** the constancy of business capital investment.

Now we turn to the constancy of consumption and residential investment shares. From (24), we have

$$\lambda_{3t} H_{t+1} = \beta\omega_1 + \beta (1 - \delta_h) \lambda_{3,t+1} H_{t+2}.$$

With the no-bubble condition

$$\lim_{t\to\infty} \beta^t \lambda_{3t} H_{t+1} = 0,$$

it is simplified as

$$\lambda_{3t} H_{t+1} = \beta\omega_1 \left(1 - \beta\left(1 - \delta_h\right)\right)^{-1}.$$

Combining it with the conjecture and (25) that

$$\lambda_{3t} H_{t+1} = \left(\Pi_h / \Pi_c\right) \left(\delta_h\right)^{-1},$$

we have

$$\Pi_h = \beta\omega_1\delta_h \left(1 - \beta\left(1 - \delta_h\right)\right)^{-1} \Pi_c.$$

Now the clearing of goods market (18) and (26) imply that

$$\Pi_c + \Pi_h = 1 - \Pi_k,$$

where Π_k is given by (29). Combining these conditions we get

$$\begin{aligned}
\Pi_c &= (1 - \Pi_k) \left(1 + \frac{\beta\omega_1\delta_h}{1 - \beta\left(1 - \delta_h\right)}\right)^{-1}, \\
\Pi_h &= \left(1 + \frac{\beta\omega_1\delta_h}{1 - \beta\left(1 - \delta_h\right)}\right) \Pi_c,
\end{aligned}$$

which proves that Π_c, Π_h are also positive **constants**, strictly in between 0 and 1. Thus, we have verified the conjecture that the consumption and investment shares are indeed constant over time.

Now, substituting this into (27) shows that

$$L_t = L \equiv L^*, \ \forall t.$$

A.2 Proof of (14)

Taking natural log of (28) we get (14), with

$$\theta_q = \ln\left(\frac{1-\delta_h}{\delta_h}\right), \ \theta_r = \ln \omega_1.$$

A.3 Proof of (15)

We want to relate the equilibrium rent with other variables, such as labor/population, wages, etc. A natural starting point is (14). Combining with equations (8) and (11), (14) can be re-written as

$$\begin{aligned} r_{ht} &= \theta_r' + y_t - h_t, \\ &= \theta_r'' + \theta_1 a + \theta_1 k_t + (1-\theta_1) n^* - \theta_2 p_t - h_t, \end{aligned} \quad (30)$$

for some constant θ_r', θ_r''. This equation says that the rental is positively correlated to the aggregate output y_t, the stock of business capital k_t, the total amount of effective labor n^*, but negatively related to the price of importables p_t and the stock of residential housing h_t. These are the first two expressions of (15). Also, we can also derive the relationship between the equilibrium wage and the rental. In this model, given the constant returns to scale production function and competitive factor markets, it is easy to see that the equilibrium wage is simply the marginal product of the effective labor unit. By (17),

$$W_t = \Theta_0 (1-\theta_1) (A)^{\theta_A} (P_t)^{-\theta_2} (K_t/\mathcal{N}(1-L_t))^{\theta_1},$$

or, in log form,

$$w_t = \theta_w + \theta_A a - \theta_2 p_t + \theta_1 (k_t - n^*).$$

Substituting this into (30), we get

$$r_{ht} = \theta_r''' + w_t + n^* - h_t,$$

which is the last expression in (15).

Table 1

Summary Statistics

	Mean	Median	St. Dev.
Apartment Rent	$ 632	$ 585	$326
City Population	7.65 mill.	4.65 mill.	7.2 mill.
Hourly Wage	$ 9.0	$ 8.5	$6.0
Openness (NBER)	66.7	54.8	59
Share of city population in Country population	0.20	0.17	0.18

Note: The NBER index is defined as (Imports + Exports)/GDP.

Table 2

Sample Correlations

	Apartment Rent	City Population	Hourly Wage	Openness	City Share
Apartment Rent	1				
City Population	0.30	1			
Hourly Wage	0.56	-0.09	1		
Openness (NBER)	0.28	-0.34	0.02	1	
Share of city population in Country population	0.32	-0.03	-0.13	0.70	1

Table 3

Dependent Variable is the Log of Apartment Rent

	(1) OLS	(2) OLS	(3) IV
Constant	2.96*	2.97*	1.44*
	(0.46)	(0.59)	(0.24)
City Population	0.18*		
	(0.05)		
Openness	0.02*	0.019*	0.012**
	(0.005)	(0.007)	(0.006)
Income	0.35*	0.17*	0.19*
	(0.05)	(0.06)	(0.07)
GDP		0.16*	0.17*
		(0.05)	(0.06)
City share		0.15*	0.17**
		(0.07)	(0.09)
Adj R2	0.44	0.45	0.35

Note: 1) Cross-sectional OLS and IV regressions. 2) All variables are in log form except openness ratio. 3) We utilize heteroscedasticity consistent standard errors. 4) * Significant at 5% confidence level. ** Significant at 10% confidence level.