Land Price Data and Land Value Functions in Cracow, Poland

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Abstract

The results of the analysis reported in this paper provide new insight into the evolution of an urban land market in a centrally planned economy undergoing transformation. Since the end of the Second World War, land use in Poland has been determined administratively. From early 1993 to late 1999 prices have been driven by market conditions in an economy undergoing transformation and influenced by anticipated land uses. This study reports the legislative, economic and political evolution during this time frame, describes the database developed to explore the evolution of the land market, and the results of an initial analysis of that data. The database permits the estimation of land price indexes by type of land use and land price gradients for different types of land uses and for different time periods from 1993 to 1999. Plots of price indexes, two-dimensional plots of univariate land price gradients and three-dimensional plots of estimated land price functions are among the figures presented in order to provide insight into the data set.

The key results of this initial study are:

- the fit of the estimated land value function declines as time passes, and
- in most cases the slope of the land value function becomes steeper as time passes.

The former result is consistent with previous studies over a much longer time frame in New York and Chicago while the latter is not. To understand these results it is necessary to revisit the assumptions that underlay models of land prices and rethink these in the context of a transforming economy. That is our agenda for further research.

Please note: The hard copy version of this paper has an extensive (almost 60 page) appendix. Due to size restraints, the appendix could not be posted. If you would like to request all or part of it, you may order the hard copy from help@lincolninst.edu or send an email asking for particular figures or tables to the same address.

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Introduction

This study builds on earlier research into the evolution and development of urban land markets in transition economies of post-socialist countries exemplified by the City of Cracow in Poland. Urban land markets have undergone radical changes during the transition period beginning in 1990 with the passage of laws introducing and implementing the legal and institutional framework for a market economy in Poland. The early stages of the transition process focused mostly on macroeconomic stability measures with relatively little emphasis on microeconomic efficiency of factor markets. This policy was premised on an assumption that sufficiently radical changes in macroeconomic environment would force changes in microeconomic behavior. The inevitable recession triggered by the breakthrough lasted only 3 years and by the end of 1992 the new economy registered growth. In 1993, real GDP grew at a rate of 3.8%. Since then Poland's economy has been able to maintain growth between 4.1 and 7% per annum to more than make up for the negative growth experienced in the initial years.

Urban land markets have undergone dramatic shifts during this time, however, there is concern that urban form has not yet evolved in a manner consistent with a market economy. Said another way, land markets are still influenced by the legacy of a centrally planned economy. As the country enters into the second decade of transition under the imperative of continued economic growth, the issues of both factor market mobility and urban productivity stand to gain increased emphasis. Urban land markets, and generally the real estate sector, still reflect the legacy of centralized decision making in a planned economy and the consequent misallocation of resources. This sector could become an impediment to further growth in urban productivity and better macroeconomic performance. At the same time little is known about this sector, since most microeconomic research and policy interest has focused on labor and capital markets as well as on the enterprise sector. Consequently, there is a need for more research into the area of urban land markets in transition economies beginning with description, followed by analysis with the goal of identifying possible policy prescriptions and guidelines. This paper aims to contribute toward reaching this goal.

The overall goal is to contribute to the development of efficient urban land markets necessary to support continued growth of urban productivity in transition countries. The aim of this project is to facilitate the development of more efficient urban land markets through the creation of a land sales information infrastructure based on a case study of Cracow. The land sales monitoring effort developed for the project in Cracow is unique in that since 1993, information on virtually every land transaction has been collected. There have been tradeoffs regarding the type of data needed for the analysis and the cost and time involved in their collection. The database has permitted the estimation of land price indexes and value functions that describe the Cracow land market and its evolution. The practical goal is for these data and analyses to be used to better inform land use planners, policy makers and the private sector. For example, the price data has been helpful in developing proposals for property tax reform now in process. Also, there has

been critical analysis that has argued that land use planning has been driven more by the legacy of existing land uses from then communist period rather than current market prices and transactions.

This paper is organized as follows: Section I provides a context for understanding the role of urban land markets in the transformation of the Polish economy. Section II consists of a descriptive overview of the development of land markets in Poland during the 1990s transition period. Section III describes the land sales data collection exercise in Cracow. Section IV provides the theoretical context for this study. Section V reports on the inter-temporal modeling of land prices, the cross sectional estimates of the land value function along with summary of graphical presentation of the data. Conclusions and an agenda for future research are presented in Section VI.

I. Urban Land Markets and Economic Transition

The Economic Transition Process in Poland

The early introduction of the legal and institutional framework for the new market economy was a difficult challenge for reformers.[1] Reintroduction of the market based real estate sector was complicated because some elements of this sector had survived through the socialist period.[2] On the other hand, almost all non-residential urban property had been legally allocated to state owned enterprises and institutions. The need for the design of an integrated framework for urban land market reforms was overshadowed by the pressure of rapid macroeconomic reforms and the lack of resources for proper research and development. This led to heavy reliance on foreign advice focused on macroeconomic issues or on relatively fragmented aspects of selected sectors.[3] Consequently, actual reforms that would affect urban land markets had to be piecemeal and scattered, although some general sequencing was attempted.[4]

The basic reforms included definition, protection and registration of property rights in land, both freehold and leasehold[5], which are alienable, mortgageable and inheritable. These rights were vested in contemporary and restituted owners (if they existed) and users holding so called occupancy rights, who were not subject to restitution. Most of these users were given full ownership of buildings and leasehold rights to land. Thus, possible restitution claims to land could be resolved by the state or municipality.[6] Trading of these rights was to be facilitated by the privatized notary offices where actual transfer of title would, by law, take place[7], by the creation of appraisal and brokerage professions[8], and by efforts to create mortgage financing mechanisms.[9]

Implementation of these reforms has suffered from a variety of practical problem that have not been resolved by the existing legal framework. For example, property rights registration has lagged seriously.[10] The development of capital markets for real estate debt has lagged because a large portion of households have chosen to spend their savings on automobiles or on direct consumption. This is in contrast to other OECD countries where the use of financial leverage on real estate assets is common.[11]

II. Market Development and Information Infrastructure

Developing Land Markets in Poland

The perceived need for the reallocation of urban land resources calls for policies that facilitate urban land market activity. Removal of constraints on exchange should engender a more efficient allocation of uses. The dominant attitude of the early reform philosophy was that it was sufficient to create basic macroeconomic stability and competitiveness, establish property rights, their protection and transfer mechanisms, including privatization channels, and these markets would develop spontaneously increasing their efficiency on the way.[12]

There has been growth in transaction volume. Poland is a country of almost 40 million people, 31.3 million hectares of land divided into 28.7 million parcels, 4.5 million buildings and almost 11 million dwellings.[13] Land sale activity as measured by the number of transactions has increased except for the most recent full year reported here (1998). Tables 1 and 2 show the number of market transactions by four categories: total, privatization (sales by state and municipalities, most often dwellings), land leaseholds (newly established or confirmed by law to sitting users), and non-governmental urban property (including cooperatives).

The tables show the growth of market driven urban property transactions.[14] The volume of land leaseholds has slowed relative to the others. This may be explained by the slow-down of legal confirmations of sitting users and by the law allowing for conversion of residential land leaseholds into freeholds.[15] The latter contributed also to the growth in 1998 of privatization sales and the increased sales of municipal and state enterprise dwellings.

Challenges of Reform Implementation

While the definition of property rights was established early in the transition process, including constitutional guarantees for private property rights and a registration and transfer system, the actual implementation of this legal and institutional framework has not been completed. For many properties, including very valuable ones, protracted testate court proceedings have not yet resolved the issue of ownership.[16] Consequently, much valuable land is still tied up in court proceedings and is not part of the current available supply of land.

Some property owners have chosen not to complete the costly title registration process, since the right of possession allows them to continue use of the property while payment of land survey costs and court registration fees connected with formal title registration is deferred. The lack of legal title is still widespread since the acquisition of real property during the five decades of the communist system was often through the administrative allocation of use rights. [17] Thus many property owners cannot deliver the title. Often, to facilitate sale, the ‘owner’ may attempt to impose the costs of clarification of title on the buyer.

In this respect, the Polish land market is similar to those of many asset-rich and income-poor developing countries. One possible difference, is that in many larger cities much of the publicly-owned and privately-used land is held in the form of long-term land leaseholds or perpetual usufruct which provides an alternative to the use of leverage for the party controlling the property.[18] Finally, some properties may not have an apparent owner, because the former owner, still traceable in the pre-war land registry books, cannot be located. If no one has registered an inheritance claim and the state has not confiscated the property for the non-payment of taxes, the property remains in limbo.[19]

While real property now has the right of ownership and use, may actors do not yet appreciate the value of real estate assets in the production process. Many owners still understand real estate to be a physical thing from the perspective of a survey or engineer rather than a factor of production with associated opportunity costs.

The reforms introduced land ownership to many new decision-makers arising from the decentralization of state property to local authorities, the vesting of real property rights to contemporary users, the privatization of public property, and the restitution of prewar private property. However, many of these actors did not and still have no tradition of seeing their land and buildings in economic and financial terms.

New professions had to be created to perform appraisal, brokerage and management services. These professionals were often land surveyors, building engineers, architects and lawyers educated and trained in the former system thus they often lacked a market perspective. Yet other new 'professionals' did not have the benefit of training in an allied field.

Decision-makers have also lacked market information. Few cities have created systems to monitor what is happening in their local markets because information has not been a priority not has the the value of information in pricing and decision making been recognized. Macro-economic policy makes have been loath to focus on issues related to institutional implementation once a broad legal and regulatory framework has been established under the presumption that the "invisible hand" will take care of the remainder. For example, real estate professionals have been slow to create multiple listing services.[20] The local taxing authority is legally obligated to monitor local markets, but usually is not interested, or even allowed, to share this information with others.[21] Market demand for sales monitoring has been insufficient to make this activity into a viable privately run service. [22] Decision-makers who do face the imperative of making an investment are often left with incomplete and often unreliable information. Land use planning occurs in a similar vacuum and thus may be poorly informed about and have little relevance to market activity. For example in a recent study on behalf of the World Bank, Alain Bertaud notes that the rezoning in Cracow, introduced in 1995, was driven more by the existing allocation of land uses, a legacy of the socialist era, than current land prices and transactional activity.[23]

The Marketplace Today

Despite regulatory advances, efficiency of real estate markets in Poland is still hampered by unclear titles to land, participants with insufficient economic and financial knowledge about real estate, and limited market information on which to base decisions. Nonetheless, transactions occur quickly and easily through the privatized notary system, but costs are very high amounting to over 10% of transaction price.[24] Thus, it is possible that the real estate market has not played its full role in the reallocation of urban land resources, a critical step in the evolution of local economies in Poland.

III. Land Sales Data Collection in Cracow

Cracow was chosen for this study because of the availability of land sales data covering the period of economic growth during the transition process of the 1990s (1993-1999). The city grew from about 200,000 at the onset of the socialist rule to 750,000 by the end of the regime. Consequently, many land use allocation decisions and real estate development took place while a non-market system was in place. The spatial structure of the city reflects the legacy of the communist period with large industrial tracts near the urban core, limited commercial development in the core and high density residential development several kilometers from the core. These land uses patterns reflect a system where land had no market value, transportation was free, the opportunity cost of time was low and planners valued proximity of residential uses to work sites. Land use reallocation should make itself evident as the city has a robust economy with industries spanning the spectrum from primary to tertiary sectors. One certain change is that market forces will shift growth toward the service sector. Cracow also has a substantial agricultural sector within its extensive boundaries and a populous agricultural hinterland. Some of these parcels are available for redevelopment while some are not.

A Brief Profile of Cracow

Cracow is at the center of the Southeast region in Poland called Malopolska. This region forms Poland's entire border with Slovakia and 3/4 of the border with Ukraine. The distance is shorter from Cracow to Slovakia and to the Ukraine than to Warsaw, the capital of Poland. Many Romanesque, gothic, renaissance and baroque buildings make Cracow an integral part of the classical Central European cultural zone together with Bratislava, Budapest, Lviv (Western Ukraine), Prague, Vienna and the northernmost cities of Italy and Slovenia. The largest extant medieval central market square is located in Cracow. The city is an important tourist attraction in Poland for sightseeing, conferences and is a gateway to the mountain recreational playground in the Carpathian or Tatra Mountain area on the southern border of Poland. The city of Cracow is the third largest city in Poland with an area of 327 km2 accommodating a population of 750,000 in the city proper and about 1 million in the metropolitan area. There are about 80,000 students, many of them from outside the city consistent with the intellectual tradition and role as a center for education.

The city is officially divided into 18 districts, but customarily divided into 4 major functional and historical areas: the Center (Srodmiescie), the West End (Krowodrza), the South Bank (Podgorze), and the East Side (Nowa Huta). There are also 230 smaller geographic units known as obrebs that are used in land surveying and title registration for the unique identification of lot numbers. See Figure 1. The Center is densely populated and used intensively for commercial and administrative functions. Its population includes 21% of city's inhabitants and is very desirable for both residential and commercial land uses. The most attractive residential area outside the Center is the West Side. The population of the West side, Krowodrza includes about 22% of city's inhabitants.

The Center and the Westside comprised the city of Cracow for many centuries and today they constitute 43% of Cracow's population. When technology allowed easier river crossings with longer bridges, the Austrians, during their occupation of Cracow in the 19th century, built a city on the South Bank of the river Wisla (Vistula). The South side, Podgorze, became oriented towards industry and less affluent households. After World War II, many socialist block estates were constructed in that area. Recently, the area leading towards the rolling hills in the south and the mountains has become more popular for residential purposes. The population of the South side constitutes 28% of Cracow's population. The latest area developed after the war with heavy industry and socialist block estates was the Eastside. It is considered to be the least attractive area for residential purposes, but it possesses high potential for becoming the consolidated industrial hub of Cracow as the city seeks to reduce industrial land uses and focus those remaining at the periphery of the city. This area is inhabited by 29% of Cracow's population.

The built-up area of Cracow constitutes 139 km2 (out of the total of 327 km2). Its land uses are divided into 35% residential, 21% industrial, 18% transport, 9.5% commercial, 9% green and the remainder in various other uses. What is striking and typical for post-communist cities is that the proportion allocated to residential and commercial uses is relatively low and to industrial uses, relatively high. This constitutes both a challenging problem for further urban development (and redevelopment), as well as an opportunity to real estate investors. See Bertaud and Renaud (1997).

Cracow's dual roles as a trading post and regional distribution center have played a crucial role in its economic base for centuries. For five centuries, Cracow was the capital of Poland and continued through much of Polish history to be the Royal Capital of Poland with coronations and burials at the nation's pantheon on the Wawel Hill. The unique accumulation of art and buildings, together with a rich cultural life made Cracow a tourist destination, creating another important economic base. In 1364, Poland's oldest university was founded here giving the City adding diversity in the area of education and research, which is a source of potential future growth. During the 1950s, the communist regime brought to the city the Sendzimar steel complex as well as various heavy manufacturing and construction industries. Nowa Huta, a model socialist town, easily recognized by its massive Stalinist architecture was built directly to the west of the mill to provide employees with nearby housing. The population almost quadrupled during the decades since the early '50s.

Cracow's Land Use Structure

The existing land use pattern reflects the development during the five decades of centrally planned urban development. The shape of the city is extended towards the East, because of the addition of the satellite town of some 250,000 people built adjacent to the steel complex[25]. The urban area in Cracow has a 10 km radius around the Center with the exception of Eastern "panhandle" occupied by the steel complex area and scattered adjacent agricultural land uses. This extends the city boundary over 20 km towards the East. The panhandle is often not considered a functional part of the urbanized land-use area of Cracow.

Urban development in Cracow exhibits a highly dispersed and fragmented pattern. The physical center of gravity is located to the east of the historic center, because of the development of a sub-center during the 1950s contiguous to the steel complex at the then eastern edge of Cracow. The western part is less urbanized with open space making it the most attractive residential zone in Cracow. There is also a lot of undeveloped land adjacent to the Northern and Southern banks of the Wisla (Vistula)) River especially in the eastern part of the city. This is the result of concern for potential flooding of the river.

The urban road network is fragmented and incomplete creating difficulties in movement of people and goods. This is partly related to the fragmented spatial structure and partly due to limited resources for the development of a complete road infrastructure for the dispersed urban spatial structure. Some non-passenger oriented railway tracks cross the city creating additional barriers to street-level traffic movement through the city. Some of these tracks, however, may be utilized for future rationalization of a rail-based public transit system. Current public transit consists mostly of tramways and buses. The tramway system, a significant investment in public transit, covers about 80 km of streets served by about 520 tram cars organized into 28 tram lines. About 60 km of these lines are separated from other traffic creating a rapid transit corridor that may increase in value as passenger car traffic increases. A new light rapid transit line (fast tram) is planned for construction on the east side of the center linking the northern and southern parts between the city center and socialist town of Nowa Huta.

Industrial land uses comprise 21% of the built-up area, high by international standards[26]. Moreover, many of the industrial zones are located close to the urban core. Many of these areas constitute low intensity land uses with obsolete multi-story factory buildings with poor accessibility, which may reduce the likelihood of their adaptive reuse. The centrally located industrial uses may impede new housing development in these areas. On the other hand, they do present opportunities for adaptive reuse although environmental or brownfield issues may slow change.

Residential land uses in built-up areas of Cracow only account for about 35% of the built-up area, which is low by international standards.[27] Centrally located industrial land uses that have not been recycled have "crowded out" residential uses both in absolute and spatial dimensions.

Cracow Land, Housing and Real Estate Markets

There are about 200,000 parcels of land in Cracow. While many are privately owned, there is fragmented ownership structure. There are some 30,000 buildings of which 6,300 are listed as historical. Cracow has 240,000 dwellings with 740,000 rooms, an average of about 3 rooms per dwelling. The ratio of dwellings per 1,000 population is 342 with 1.05 per rooms per person and an average room size per person of 17.7 m2. There are 250,000 households with an average size of 2.8 persons. The composition of the housing stock by number of rooms is 32% small (1-2 rooms), 34% medium (3 rooms), and 34% large (4+ rooms).

Land market activity in Cracow is presented in Tables 4 and 5 and shows the absolute number and rate of change of vacant land transactions between 1993 and 1999.[28] It is apparent that the total number of transactions has increased from the base year of 1993 when the economy registered its first economic growth. However, the largest volume occurred in 1996 when generous tax breaks were first offered for those who invested in residential parcels and housing construction.[29] The volume of land transactions has slowed since that time in both Cracow[30] and Poland [31] although the number of dwelling units under construction has been increasing indicating that there have been more starts and longer uncertain construction periods.[32] Anecdotal evidence suggests that many buyers are holding their land vacant until mortgage financing becomes more affordable. Some buyers are in the midst of development that may be active or inactive.[33] Others may be engaged in investment in land for capital appreciation. Taxes on land are low so holding costs are insignificant.[34] Land market activity data in Cracow indicate that sales represent only about 0.5% the total inventory of land parcels.[35] Resale activity comprised a small portion of the sales (around 1%).

The market prices of land in Cracow appear to be consistent with one's expectations with more intensive land uses priced higher. Table 6 illustrates the breakdown of residentially zoned land sales by zoning category and price. Although the prices are averaged over the full time period and individual transaction prices are adjusted for inflation, the prices generally increase with allowable density. Compact and medium-density mixed land uses have the highest land values closely followed by medium to high-density multi-family uses. The highest floor area ratios (FARs), however, do not yield the highest land values perhaps indicating that development at the highest density is not economic in the current Cracow real estate market. [36]

Data Gathering and Preparation in Cracow

The database of land sales, developed by the Cracow Real Estate Institute (CREI), spans the period of January 1993 through September 1999.[37] This database is a unique set of land sales transactions in a transforming economy with a rich variety of thirty (30) attributes including the transaction price. Some of the data have been previously used for other land market value studies.[38] The full list of variables used in the study is desribed in Appendix A.

The gathering of transactional data requires cumbersome procedures in Poland. Transactions are executed with a notary public who drafts the contract according to the law and checks compliance with various legal requirements.[39] The law requires the notary to identify the parties to the transaction, encumbrances, as well as the price paid. The buyer is then subject to transfer tax between 2 and 5% which the notary collects on behalf of the municipality. Parties to the transaction may occasionally cause the notary to include other information such as zoning. The notary then sends copies of the deed to registry court, to a technical cadastre (called land and building evidence) and to local tax chamber (which checks the price reliability). The parties have incentives to lower the declared prices, but are warned by the notary about negative consequences of inaccurate reporting of the price.[40]

To create the data set, variables taken from notary deeds[41] needed to be supplemented by other information. Servicing and infrastructure data were obtained by searching infrastructure maps held by the government agency gathering data from utility companies.[42] Zoning information was obtained from the municipal department dealing with planning permits and approvals.[43] Spatial data was created by CREI personnel who used maps to identify the X-Y coordinates of the center of each lot. Simultaneously, staff assigned frontage and depth measures to each parcel.[44] During the initial data collection exercise, CREI personnel did collect additional attributes through site visits.[45] Also, some onsite data continues to be collected. The random nature of its collection precluded these variables from being used during the periods subsequent to 1993.

The above primary variables were augmented with derived variables computed from the existing CREI dataset with our research objectives in mind.[46] From the dataset, binary, categorical or continuous variables were created.[47]

Statistics and cross-tabulations of variables were reviewed to identify outliers or incomplete records. Transactions with unreasonable values were removed from the data set after individual examination. As well, incomplete records were eliminated if information on crucial variables such as *RELX, RELY, AREA, FRNT, DPTH, GAS, WAT, SEW, ELE, BUY, DATE, P, NMB, LOT or OBR* was not available. Out of a total of 6,563 records the final data set adopted for analysis consisted of 6,100 records.

Within this data set there were two important subsets to be used for separate analyses. One set contained 760 ‘repeat sales’ transactions that could be used to compute repeat sale indexes. The other data set contained about 561 transactions with “site-visit” attributes collected during 1993.[48] The latter sub-sample allows for an assessment of the contribution of the ‘on-site’ variables. Since they are time-consuming and expensive to collect, ascertaining their contribution to analyses of land price is important.

Other data has been prepared by CREI to facilitate spatial presentations and analyses using ARCView software. There are geo-coded layers including information on municipal boundaries, city districts, *obrebs,* major streets and rivers. Geo-coded transactions can be exhibited as a separate layer.

IV. Theoretical Context

It is well known from the seminal work of Muth (1969) and Mills (1972) that the static monocentric model of the urban land market yields a model in which land prices and densities decline with distance from the center of the city. Specifically, land value falls at a constant percentage per increment of distance from the city center if it is assumed that location or transportation costs increase linearly from the city center, the price elasticity of demand for housing is unitary and that housing production is a Cobb-Douglas function employing capital and land as inputs.

$$P(u) = P_0 e^{-\gamma u} \quad (1)$$

$$lnP(u) = lnP_0 - \gamma u \quad (2)$$

Equations (1) and (2) are identical where $P(u)$ is the price of land at distance u from the center of the city and γ is the percentage rate of decline per distance measure. Despite the simple form of Equation (1), empiricists have found that since the assumptions of the monocentric model of urban land values are seldom met, analysis of land values or other measures (e.g., population density) require less parsimonious specifications.

Data sets permitting the empirical testing of theoretical structures are few but two sources for the city of Chicago have resulted in numerous studies focusing on that city beginning with the work by Mills and Muth. These sources are Hoyt (1933) and "Olcott's Land Values Blue Book of Chicago" which together provide actual and estimated values for tracts of land in Chicago at various intervals from 1830 to 1990. These sources are discussed and the data analyzed using non-parametric techniques in McMillen (1996). Inter temporal comparisons seem to indicate that as time passes, the land value function becomes more complex as transportation systems, neighborhoods, employment nodes and shopping districts evolve and multiply. For example, McDonald and Bowman (1979) find that explanatory power declines with time and that higher order functional forms do a better job of explaining variation in land price. This likely reflects the increasing complexity of the urban environment and that distance from the city center provides an inadequate explanation for changes in value. These studies also find that the rent gradient flattens with time. This follows from Equation (1) since as cities grow an identical absolute decline in value will yield a smaller percentage decline because of higher central city land values.

In another study focusing on the historical evolution of land prices in Manhattan between 1835 and 1900, Atak and Margo (1998) report similar results. The fit of the regression equation erodes and the rent gradient flattens. The authors collected sales prices of 1127 vacant parcels from newspaper reports of auction sales or transfers of real estate for 10 one year periods beginning in 1835 and ending in 1900. The authors also report an average nominal growth rate of 3% in land values between 1835 and 1895 and devote considerable space to a description of the evolving land market through the use of scatter plots and graphs of rent gradients. While others have addressed the issue of selection bias (Macmillan, Jarmin and Thorsnes, 1992) and estimation technique (Kau and Sirmans, 1979), the declining explanatory power of the model as time passes and the flattening of

the rent gradient appear to be robust findings. McDonald (1979) provides a comprehensive and integrative discussion of the evolution of the theoretical and empirical land price literature until that point in time.

Many factors can complicate the fundamental relationship depicted in Equation (2) including alternative transportation systems, heterogeneous neighborhoods and services and shopping districts and employment nodes that compete with the central business district (CBD) or the town center. Thus, a more complete specification of Equation (2) follows

$$lnP(u_i) = lnP_0 - \gamma\, u_i + \alpha \cdot g(u_i) + \beta \cdot h(x_i) + \varepsilon_i \qquad (3)$$

where the vector $g(u_i)$ represents the inclusion of second, third and fourth order polynomial terms and $h(x_i)$ is a vector of attributes of land. α and β are vectors of percentage changes in land price arising from changes in the variables that comprise the vectors $g(u_i)$ and $h(x_i)$. Prior results suggest that if land attribute data are available, the polynomial terms often included as proxies can be replaced by variables capturing the true effects on land values of a multitude of factors. Moreover, some studies have chosen to segment the community spatially as a proxy for yet other unmeasured factors.

The above model describes a long-run equilibrium in the marketplace assuming continuous redevelopment as market conditions change. In dynamic models, residential density depends on the history of development and redevelopment may not be costless. In this environment, density functions may not be smooth (Brueckner, 1986). However, if demolition is costless and there are no externalities among alternative densities, previously undeveloped land values should be unaffected by the pattern of historical development as is the case in long run equilibrium.

Selection bias is also raised as an issue in land value function estimation. Specifically, if variables are left out of the model, there is the potential for bias. McMillen et al. (1991) and McMillen et al. (1992) develop and test models which deal with the potential bias resulting from ignoring the effect of zoning and the quality of agricultural land at the periphery.

In this paper, we employ a long-run equilibrium approach to examine the urban land value function in Cracow between 1993 and early 1999. We suspect that a number of the assumptions that underlie the model may not have bben met during the time frame of this analysis. For example, the model assumes that households trade-off transportation costs and land rents. Transportation and housing costs had been subsidized so during the transformation, one might not expect the land value functions to evolve as they would in a market economy.[49] As noted previously, this is a unique data set and this paper serves as an introduction to the data and reports the results of analyses that are primarily descriptive. The goal is to place this data set in context of other data sets that have been used to evaluate land price gradients. This paper is intended to be exploratory leaving examination of the implications for the model of the economic transformation in Poland for future work. Other issues needing future analysis include the impact of development dynamics or sources of bias in the estimation of pricing models.[50]

As previously noted, the data are derived from a period in the early development of a local land market during the transformation from a centrally planned to market driven economy. The Polish economy began to recover in 1993 and has continued to experience significant real growth through the year 2000. While market transactions occurred prior to early 1993, we do not have the population of transactions prior to 1993 in our data set. We want to determine whether land value functions in a nascent market economy take on the same form as we observe in developed urban economies. As well, we want to know whether buyers and sellers recognize other factors that may impact land values and, if so, which of those factors seem to be important. We also want to determine if the robust findings of prior studies are found in an urban land market undergoing transformation from an environment where land had no value to one where individual players determine price. Specifically, we will determine if the explanatory power of the land price model declines and the rent gradient flattens as time passes.

V. Empirical Analysis and Presentation of the Data

In order to provide an overview of land market dynamics in Cracow, we report a lot of information in the form of tables and figures. We focus our discussion on the results of the estimations of the constrained hedonic price indexes and land price gradients and incorporate discussion of other analysis or figures where appropriate. Because of the amount of material presented a summary of the relevant exhibits follows.

Tables 6 and 7	Constrained hedonic price indexes and repeat sales indexes;
Figures 3 through 7	Graphs of price indexes;
Figures 8 through 12	Scatter plots of observed land prices by type of land use by year (including plots of simple price gradient estimations);
Figure 13	Map of Cracow with plots of transaction locations by type of land use;
Tables 8 through 13	Estimations of land price models by type of land use by period;
Figures 14 through 16	Plots of land price surface (actual transaction prices for all types of land uses); and
Figures 17 through 28	Plots of estimated land price surfaces (for all transactions and for selected land uses by time period).
Appendix A	Variable List
Appendix B	Test of value of ‘on-site variables’

We begin by reporting and discussing price indexes for the market and segments of the market by type of land use. In order to provide further insight into the data, we follow this with figures that include scatter plots and simple price gradient estimations by year by type of land use. We then report and discuss sequential cross-sectional estimations of land price gradients by type of land use. Since the data were generated from a seven year time period, we segment the data and estimate land price models by type of land use and

time period (three 27 month windows). Within each time period, a time trend variable is used to capture periodic growth in prices. We include a map of the population of transactions color coded by type of land use. We follow this with figures that include three-dimensional plots of actual land prices for every transaction by time period and plots of estimated land price functions by type of land use by period. Again, these are 27 month periods generated by dividing the 81 months of data into three time periods of equal duration.

Price Indexes

Table 6 reports constrained hedonic price indexes (hedonic indexes where attribute coefficients are constant across all time periods and time dummies are used to generate the index) while Table 7 reports repeat sale indexes. The indexes are reported for the population of sales and for the market segmented by land use. We did not estimate indexes for every possible land use. With only 380 repeat sales, only a limited set of repeat sale indexes could be estimated. With the constrained hedonic indexes we report only selected indexes.

We used common sense protocols to group land use categories in order to allow for sufficient degrees of freedom to estimate the indexes and also to reduce the number of indexes to report. For example, residential zoning categories 1 and 2 (*RES=1 or 2*) are the lowest density residential land uses zones while residential zoning categories 3 and 5 (*RES=3 or 5*) are medium to high density multi-family zones. Residential zoning categories 4, 6 and 7 (*RES=4, 6 or 7*) are actually mixed use categories involving medium to high density residential uses combined with commercial uses. Commercial, industrial and agricultural land uses are self-explanatory and are sometimes grouped together (or in the case of commercial with residential mixed use zones) for the reasons noted above. Note that some transactions involve parcels with more than one legal lot and, in some cases, more than one zoning category. These transactions are excluded from the analysis where appropriate.

The general form of the contrained hedonic price index model appears below. Equation (4) is similar to Equation (3) but for a series of time dummies for each quarter during the period of analysis.

$$lnP(u_i) = lnP_0 - \gamma\, u_i + \alpha \cdot g(u_i) + \beta \cdot h(x_i) + \Sigma\, D_t + \varepsilon_i \qquad (4)$$

There is significant volatility in the individual price indexes. Prices are measured in real terms (PLN, new Polish zloties) adjusted for inflation. Also, over the six or more year time frame of the analysis, the variation in the rate of price increase by type of land use is significant. The growth rate in all land values over the twenty-seven quarter period is just under 17% per year in real terms. This is an incredible rate of real growth given that inflation during this time frame was typically in double digits declining steadily from 35.3% in 1993 to13.0 % in 1998 and then 8.4% in 1999. The price indexes for multi-family residential (*RES=3,5*) and agricultural land perform the worst ending the analysis period below the initial price levels. Both indexes, however, were above their initial levels in the last quarter of 1998 and the first two quarters of 1999. Subsidies to the multi-

family sector were ended in the mid-1990s and rent control is still place although it will be phased out starting in the year 2000. Land zoned for agricultural use in the city should not benefit from city growth or expectations about land value changes unless there is an expectation that the zoning can be changed.

Land zoned for low density residential uses (*RES=1,2*) appreciates immediately in 1993 and shows sustained appreciation starting in late 1996 through 1999:3. In the early 1990s, there were subsidized housing finance programs in place and entrepreneurial developers aggressively acquired residential sites to satisfy housing demand through pre-sale construction contracts. Over the 27 quarter period, the compound growth rate for low density residential is 13.08% and for low density and compact residential is 12.57%.

Because of the large number of low-density residential transactions, we are able to report hedonic indexes for each quadrant around the urban core. That is, we segmented the transactions into NW, NE, SE and SW quadrants. While again, there was considerable volatility in the individual indexes, low density residential land in the NW and NE quadrants increased at annual rates of 20.92% and 18.92% respectively. Land in the SE quadrant has appreciated rapidly during 1999 having languished during most of the decade. There have been limited recent transactions in the SW quadrant making any conclusions about prices during the last few quarters suspect. The preferred residential neighborhood in the NW known as Krowodrze (the West Side), has generated the highest rate of growth in land values.

When we turn to mixed uses and commercial uses it is another story. Although there is more volatility, these indexes do not significantly outperform the residential indexes until after 1995:2. After that point, commercial values are influenced by high demand for retail locations (e.g., for hypermarkets, fast food outlets and gas stations), distribution sites and office sites. Mixed use sites (*RES=3.6 or 7*) and commercial sites appreciate over 30% per year over the full time frame. Relatively few industrial sites sell so we do not generate a unique index for those transactions. However, the combined industrial commercial index appreciates at a rate of about 25% per year. Note that there are a few transactions beginning in about 1996 at prices in excess of $200 per square meter for commercial parcels. While prices in general are increasing, these seem to be extreme values. Research into individual transactions indicated that these prices were typically paid by global firms seeking for key parcels to establish competitive advantage near the urban core. We removed ‘outliers’ from the data and recomputed the indexes with minimal effect. We concluded that the while these transactions were unusual, they were part of the overall movement of commercial and mixed-use property values over this time frame and were the result of arms length negotiations.

In Table 7, we report repeat sale indexes for all transactions and low density residential transactions (*RES=1 or 2*). These indexes are graphed in Figure 5 and compared to their corresponding hedonic indexes in Figures 6 and 7. The results suggest that there are insufficient repeat sales to give a true picture of price changes during the time frame in question. Part of the problem is that there is dramatic price volatility. We leave more intensive examination of these indexes for future research.

Scatter Plots and Univariate Land Value Functions

In order to provide a systematic insight into the database, we plotted the natural log of price by distance to the city center for every transaction by type of land use and year. Included in each of these plots, is also a fitted regression line.

$$LRUP = \alpha + \beta * DIST + \varepsilon \quad (5)$$

The dependant variable (*LRUP*) is the log of the real unit price of each land sale where unit price is the real price per square meter in the new Polish currency using a 1993 base year. The distance from the lot's center to the center of the square in old Krakow is the variable *DIST*. Each parcel has an X-Y coordinate and this permits the computation of a distance measure directly to the center of the city.

We were not able to estimate Equation (5) for all land uses for every year as there were not adequate records in some years. The scatterplots appear in Figures 8 through 12.

Land Value Functions: Introduction

Figure 13 is a plot of the location of every transaction in the data set color coded by land use type. Visual representation of the transactional data provides a lot of insight beyond the econometric analysis to be reported below. The transactions of land zoned low density residential (*RES=1,2*) are dispersed throughout the urban area with the exception of the urban core. The transactions of land zoned higher density residential (*RES=3,5*) and mixed use (*RES=4,6,7*) tend to be located relatively near to the urban core and along transportation nodes (between 2 and 8 kilometers from the city center). With a few exceptions, transactions of land zoned for commercial uses are also located near the urban core or along transportation nodes. There are some exceptions at the western and southern edges of the city where commercial parcels in key locations or along key arteries have transacted. Industrial land sales are less prevalent and tend to be located to the south and east of the old town between Nowa Huta and the communities of Wola, Duchaka and Nowy Biezanow. Agricultural land transactions tend to be at the city's periphery beyond 7 or 8 kilometers from the city center. However, in the northwest sector a number of transactions are relatively close to the urban core. Note that one of the agricultural zones includes the right to build on it.

Tables 8 through 13 include the estimations of the land value functions for all sales (Table 8), low density residential (Table 9), multi-family residential (Table 10a and 10b), mixed use (Table 11), commercial and industrial (Table 12) and agricultural (Table 13). Typically, we estimated models of the form depicted in Equation (3). However, we usually did not include higher order polynomial terms in the vector $h(x_i)$. We tried to estimate the same functional form in all cases for consistency and comparability. Better fitting specifications could be estimated for individual land uses and time periods but we chose, instead to employ a common specification that follows in Equation (6).

$$LRUP = \alpha + \beta_1 * DIST + \beta_2 * LANGLEN + \beta_3 * LAREA + \beta_4 * TEL + \beta_5 * HEAT + \beta_6 * SEW + \beta_7 * MONTHS + \xi \quad (6)$$

The dependent variable (*LRUP*) is the log of the real unit price of each land sale where unit price is the real price per square meter in the new Polish currency using a 1993 base year. The distance from the lot's center to the center of the square in old Krakow is the variable *DIST* . Each parcel has an X-Y coordinate and this permits the computation of a distance measure directly to the center of the city. *LANGLEN* is the log of the angle between the north/south axis and the location of the transaction measured in degrees. *LAREA* is the log of the area of the lot. Even though we are using the per unit price of the lot, it is assumed that larger lots might bring a discount on the per square meter price, all other things being equal. *TEL* is a measure of accessibility to a telephone line. *HEAT* is a measure of access to the district heating system. *SEW* is a measure of access to the sewer system. Appendix A includes a description of all of the variables including a number of other variables that measure the accessibility of the site to public services and infrastructure. Other variables include *ELE, GAS*, and *WAT* that measure respectively, accessibility to electricity, gas and water. Not surprisingly there is significant correlation among these variables so only a subset are used in the final specification. Finally, *MONTHS* is simply an ordinal measure of the number of months that have passed during the sample period.

During the early years of data collection, on-site variables (*ECO, NGH, ACC, BLD, DET, TPT* and *AME*) were collected by physically visiting each parcel that had sold. These variables were only collected consistently during 1993. We include in Appendix B, an analysis of the value of collecting this additional data. While some of the variables prove to have explanatory power in the land pricing model, that benefit is not consistent across different types of land use. The value of the additional data in estimations of the price model does not seem to justify the significant cost of its collection.

Land Value Functions and Plots of the Price Surface

In the sections that follow, we will analyze the estimated price surfaces by type of land use by period. Tables 8 through 13 include these estimations beginning with the full population of transactions and then for subsamples by type of land use including *RES=1* or *2, RES=3* or *5, RES = 4, 6* or *7, COM =1* and *IND =1* and *AGR =1.* As is appropriate to provide better insight into the price dynamics, we will reference other data presented previously including the constrained hedonic price indexes in Table 6 and Figures 3, 4 and 5.

Figures 14, 15 and 16 are three-dimensional plots of the actual transaction prices for all types of land uses in each of the three time periods. A surface is created to better represent the three dimensional aspect of the price and the locations of the transaction. The orientation is from the southeast so the viewer can observe the relatively high price land transactions in the urban core and surrounding neighborhoods and the drop in values as one moves to the east or away from the urban core in other directions. One can also see that there are other submarkets in which high priced parcels have changed hands.

Figures 17 through 28 are plots of the estimated price surfaces for all transactions using results of some of the estimations reported in Tables 8 through 13. Specifically, we generated price surfaces for all types (Figures 17, 18 and 19), then residential (Figures

20, 21 and 22), mixed use (Figures 23, 24 and 25) and agricultural (Figures 26, 27 and 28) simply to illustrate in three dimensions the evolution of land values and land markets for selected types of land uses.

Land Value Functions: All Types of Uses

Table 8 reports the results of estimations of the land value function for all types of property. The estimations are run for 27 month periods (2 years and 3 months) a convenient division of the time frame from which the data were collected (1993:1 through 1999:9). In the first time period (1993:1 though 1995:3), all of the coefficients in this specification of the model are significant and of the expected sign except for the coefficient on the variable *LANGLEN* which is not significant and on *HEAT* which, though significant, is of the wrong sign. The coefficient on *MONTHS* indicates that prices declined slightly less than 1% (0.81%) per month during the first 27 month period. This result is also clear in Figure 6, which shows both the constrained hedonic and repeat sale index for all sales.

In the second time period (1995:4 through 1997:6), all of the coefficients are of the expected sign and significant. In the third time period (1997:7 through 1999:9), all the coefficients are significant. However, the sign of the coefficient on *TEL* is of the wrong sign. The coefficient on *MONTHS* indicates that prices increased about 2% (1.99%) per month during the second time period and almost 3% (2.95%) per month during the third time period reflecting the recovery in the market. This result is also clear in Figure 6, which shows both the constrained hedonic and repeat sale index for all sales. Perhaps most relevant, is the decline in the fit of the estimated land price model through time. The adjusted R^2 declines from 0.5664 in the first time period to 0.4200 in the second period and 0.2393 in the third period. This evolution in the fit of the model is consistent with prior studies undertaken over a much longer time frame in Chicago and New York. Another robust result from prior studies is the flattening of the land value function through time. The absolute value of the coefficient on the variable *DIST* rises slightly from the first period to the second period (-0.00015 to –0.00017) and then declines to –0.00002.

Figures 17, 18 and 19 present the estimated price surfaces for all land use types for each time period respectively. The price surfaces, uninfluenced by the extreme values included in the prior three figures, clearly show the impact of distance from the city center on price. The figures have a conical shape although there appear to be other relatively high priced nodes in addition to the city center. In period 1 and 3, some particularly high valued transactions are evident just north of the urban core. The cone appears to thicken in period 3 (Figure 19) which is consistent with the flattening of the price gradient reported in the prior paragraph.

Remembering that the perspective is from the southeast, one can see that the gradient is steeper to the north, south and east and land prices are higher at the periphery to the north, south and west. The low prices surrounding the Sendzimar steel mill site to the east of the urban core are obvious. There are few transactions within the site but the low

prices surrounding the area result in the flat price surface extending out to the periphery in the east.

Figures 17 through 28 were created using a geostatistical gridding technique known as kriging. Gridding is the process of interpolating irregularly located data onto a regularly spaced array of points with the goal of creating a more meaningful contour map. Kriging involves the use of variograms which are used to specify the spatial variability of the data set. Recently, these techniques have been employed to increase the predictive accuracy of models used to estimate real estate prices. The rationale is that there a numerous localized factors which influence value but which are not typically measured. To the extent that these factors are constant within geographically distinct submarkets, techniques like kriging can be very helpful in providing better representations of the price surface. Thibodeau et al (1999) and Thibodeau et al. (forthcoming) provide a good overview of this rapidly evolving area of research.

Land Value Functions: Low Density Residential

We now turn to Table 9, which presents the results of estimations of the land value function for the low density residential land uses (*RES=1,2*). The estimations are again run for 27 month periods (2 years and 3 months). In the first time period (1993:1 though 1995:3), all of the coefficients in this specification of the model are significant and of the expected sign except for the coefficient on the variable *LANGLEN* which is not significant and on *HEAT* which, though significant, is of the wrong sign. The coefficient on *MONTHS* indicates that prices declined slightly less than 0.5% (0.42%) per month during the first 27 month period. This result is also clear in Figure 7, which shows both the constrained hedonic and repeat sale index for low density residential land uses. However, unlike the indexes reported for all sales, the constrained hedonic low density residential index increases initially through the sixth quarter and then shows some weakness. Also see Table 6 for numerical values for these indexes. With the exception of the positive price appreciation in the low density residential sector, these results are virtually identical to those previously reported for all sales. This is not surprising since about two-thirds of the population of transactions are zoned low density residential (*RES=1,2*).

In the second time period (1995:4 through 1997:6), all of the coefficients are of the expected sign and significant except for the coefficient on the variable *HEAT.* In the third time period (1997:7 through 1999:9), all the coefficients are significant except for those for *TEL* and *HEAT.* The coefficient for *TEL* is of the wrong sign. The coefficient on *MONTHS* indicates that prices increased about 1.5% (1.44%) per month during the second time period and almost 3% (2.81%) per month during the third time period reflecting the recovery in the market. This result is also clear in Figure 7, which shows both the constrained hedonic and repeat sale index for low density residential land uses. Again, most relevant, is the decline in the fit of the estimated land price model through time. The adjusted R^2 declines from 0.5040 in the first time period to 0.3916 in the second period and 0.1095 in the third period. The absolute value of the coefficient on the variable *DIST* rises slightly from the first period to the second period (-0.00014 to –0.00016) and then declines to –0.00001.

Figures 20, 21 and 22 present the estimated price surfaces for low density residential land uses. What is most striking about the price surfaces is that prices actually seem to decline in the urban core while prices of properties distant from the city center appear to appreciate with time. One interpretation of this is that well located properties near the city center attracted the most interest initially simply because of their location and, perhaps, their investment or speculative appeal. As the economy stabilized and consumer confidence increased residential locations further from the urban core attracted interest perhaps for potential development.

Land Value Functions: High Density Residential

We now turn to Table 10a, which presents the results of estimations of the land value function for the high density residential land uses (*RES=3,5*). In the first time period, the coefficients for *LANGLEN, LAREA, TEL* and *HEAT* are not significant. The coefficients for *SEW* and *MONTHS* are significant and of the correct sign. The coefficient on *MONTHS* indicates that prices decreased slightly less than 2% (1.81%) per month during the first 27 month period. This result is also clear in Figure 3, which shows the constrained hedonic indexes for low high density residential uses, mixed uses and commercial uses. Also see Table 6 for numerical values for these indexes.

The estimation results for the second time period (1995:4 through 1997:6) are not strong. Neither the constant term *C* or *DIST* are significant. The remaining coefficients are of the expected sign and significant except for the coefficient on the variable *SEW*. The coefficient for LANGLEN is positive which is consistent with our prior that parcels in the northwest quadrant are the most valuable. In the third time period (1997:7 through 1999:9), all the coefficients are significant except for those for *LANGLEN, SEW* and *MONTHS.* The coefficient for *TEL* is of the wrong sign. The coefficient on *MONTHS* indicates that prices increased about 1.5% (1.43%) per month during the second time period and just over 0.4% (0.45%) per month during the third time period reflecting the recovery in the market. However, as noted previously, the coefficient for *MONTHS* is not significant. The decline in the fit of the estimated land price model through time is evident between the first and second time period. However, in period three the adjusted R^2 increases unlike the fit of the models for the prior land uses we have examined. The absolute value of the coefficient on the variable *DIST* declines from the first period to the second period (-0.0002 to –0.00019) but is not significant and then the absolute value of coefficient increases again (back to –0.0002).

Because of these inconsistent results, we estimated an alternative, simpler specification of the model which is reported in Table 10b. We eliminated the hedonic variables other than *DIST* or *MONTHS* from the model and then added $DIST^2$ (the distance from the city squared), a second order polynomial term. While the coefficients for all other variables are significant and of the expected sign in all periods, the coefficient for $DIST^2$ is not significant in the initial time period (but is elsewhere). The coefficient for $DIST^2$ has a positive sign and for *DIST* has a negative sign indicating that the value for land for high density residential uses increases initially as distance from the city center increases and then declines at distances further from the city center. This result probably arises from the high density residential uses built adjacent to the industrial areas about seven kilometers

from the urban core. The coefficient for the variable *MONTHS* indicates that values decreased during the first period at roughly 2% (1.91%) per month, increased during the second period at more than 1.2% (1.26%) per period and during the third period at 2.3% per period.

Land Value Functions: Mixed Use

We were unable to estimate complete models for the three time periods for mixed land uses (*RES=4,6 OR 7*) as there were not sufficient transactions during the initial period. We simplified the model to be estimated in the first period. The results are not as consistent as those presented prior. The key results follow and are presented in Table 11. The coefficients for the variable *DIST* are negative and significant and the absolute value of the coefficient doubles between period two and period three. The growth rates in the price of mixed land uses is just over 2% (2.07%) per month in period two and over 7% (7.24%) per month in period three. While the specification in period one is different, the coefficient for the growth rate is also significant but negative. The growth rate during this period is –2.3% (2.38%). The adjusted R^2 is high in period one (0.5034), falls in period two to 0.1270 and then rises again to 0.3784. The results suggest that there has been a change in the market environment for mixed use land. Note that there are only 43 mixed use transactions in period 1.

Figures 23, 24 and 25 present the estimated price surfaces for transactions involving mixed land uses. Note that these are properties with floor area ratios of 1.0 to 1.9 incorporating both residential and commercial land uses. There is clearly significant appreciation in this sector and well located properties near the urban core appear to benefit. Comparing the price surfaces presented in Figures 24 and 25, this appreciation is clear. The increasing absolute value of the gradient is also evident as land prices at the periphery do not rise as by the same multiple.

Land Value Functions: Commercial and Industrial Uses

We now turn to Table 12, which presents the results of estimations of the land value function for the commercial and industrial land. In the first time period (1993:1 though 1995:3), the coefficients for *C, DIST, LAREA* and *TEL* are significant and of the expected sign. In periods two and three, the coefficients for the variables *DIST, LANGLEN, HEAT* and *MONTHS* are significant and of the expected sign. The significant results follow. The coefficient in the variable *DIST* is negative. The absolute value increases between period one and two and stays relatively unchanged between period two and three. The growth rate in land values during period two is 4.14% per month and during period three is 3.41%. In period one the growth rate is negative but not significant. The adjusted R^2 during period one is 0.3447, falls in period two to 0.2475 and then falls again to 0.2318. Remember that this is consistent with prior research. As time passes, the fit of the model declines. Note although prior research has shown the slope of the value function to decline through time, in this case, the slope increases between period one and two and then remains relatively unchanged between period two and three.

Land Value Functions: Agricultural Uses

We now turn to Table 13, which presents the results of estimations of the land value function for agricultural land uses. The results here are more consistent with those found for the low-density residential uses (Table 6). The coefficient on *LANGLEN* is not significant during any time period. The coefficient in *SEW* is not significant in period one. The coefficient in *HEAT* is not significant in period two. The coefficients on *TEL and SEW* are not significant in period three. All other coefficients are significant and of the expected signs. The coefficient on *MONTHS* indicates that agricultural land values declined 1.4% per month during the first 27 months, then increased 0.22% per month during period two and finally at a rate of 1.35% during period three. Again, most relevant, is the decline in the fit of the estimated land price model through time. The adjusted R^2 declines from 0.5399 in the first time period to 0.4431 in the second period and 0.3691 in the third period. The absolute value of the coefficient on the variable *DIST* rises slightly from the first period to the second period (-0.00015 to –0.00017) and then increases further to -0.0002.

Figures 26, 27 and 28 present plots of the estimated price surface for agricultural land for each of the three time periods. The plots are not too suggestive which is not surprising. However, one can see that the price surface has shifted up to the southwest, west and northwest perhaps as a result of the increasing urbanization of these areas. Concurrently, the price surface at the eastern edge of the city has not shifted up reflecting the effects of the intervening industrial land devoted to the Sendzimar Steel Mill.

VI. Conclusions and Directions for Further Research

This working paper has several goals. The first is to describe and provide some history of the transformation of the economy in Poland with particular focus on the creation and evolution of real estate related institutions. The second is to present a summary of a unique database created in the city of Cracow. This data base includes virtually every undeveloped land transaction between January 1993 and the latter part of 1999. The Cracow Real Estate Institute continues the data collection on a periodic basis subject to resource constraints as this conclusion is written. Rather than provide tabulations of the data, we undertake some fairly rudimentary analysis to illustrate the nature of the data, to provide some insight into the evolution of the land market in Cracow and identify some directions for further research.

The results of the data analysis reported in this paper provide new insight into the evolution of an urban land market in a centrally planned economy undergoing transformation. Land use decisions were previously made administratively but during the time frame of analysis are being driven by primarily market forces. Bertaud (1999) notes the role of planners in determining a new land use plan that he argues was overly influenced by the existing land use pattern influenced, of course, by decades of administrative allocation decisions driven by socialist housing and industrial initiatives.

The key results of this initial study indicate that some of the robust results from prior studies of historic land markets in Chicago and New York are evident here. In particular,

the fit of the estimated land value function declines as time passes. In the studies of the markets in New York and Chicago, researchers have suggested that this result indicates the increasing complexity of land markets through time. What is interesting is that the studies of New York and Chicago report the analysis of data from multiple decades (New York – 65 years; Chicago – 150 years) while our study examines only six and one half year s of data. This suggests that in a transforming economy, the evolution of the land market is occurring at warp speed relative to the experience in a typical market economy.

The other result of interest is at odds with prior research. Both studies of New York and Chicago have shown that the land price gradient flattens with the passage of time. We do not find that result in Krakow. For low density residential uses the price gradient become steeper between period 1 (1993:1 – 1995:3) and period 2 (1995:4 – 1997:6) and then becomes flatter between period 2 and period 3 (1997:7 –1999:9). For high density residential uses (*RES=3,5*) and mixed uses (*RES=4,6,7)* the price gradient become flatter between period 1 and period 2 and then becomes steeper between period 2 and period 3. For commercial and industrial land, the price gradient initially steepens between period 1 and 2 and then stays virtually constant between period 2 and 3. For agricultural land uses, the rent gradient increases between periods 1 and 2 and also between period 2 and 3.

We interpret these results as follows. In cities such as New York and Chicago, most vacant land transactions will occur at the periphery as the city grows. Because their land markets have been and are market driven, these cities grew from the inside out. With growth, the land price gradient will shift up all other things being equal. This means that repeated estimations of the land price function through time will result in a coefficient for the variable *DIST* that has a smaller absolute value as the slope is becomes flatter with the passage of time. Note that a critical part of this process is that edge of the city is shifting out to accommodate new growth.

In the case of Cracow, during this time frame most of the transactions are not at the periphery; they are in-fill transactions. As the market evolves the land rent gradient rotates up from the city periphery as the prices for particular land uses are bid up as the transformation has economic effect. The initial interest in the Cracow land market was in low density residential land uses and we observe that land value gradient initially becoming steeper between period 1 and 2 and then becoming flatter between period 2 and 3. The higher density residential uses including mixed uses increase as a portion of total sales during the latter time frame in our analysis. As well, values appreciate in this sector more rapidly in periods 2 and 3. Not surprisingly, the land value gradients for high-density residential and mixed uses become steeper between period 2 and 3. The results for commercial and industrial land uses are also consistent with this story. In general, the land value gradient becomes steeper as in-fill transactions occur. One would expect through time that once most of the vacant land within the city has been acquired and developed, that the land value gradient would flatten if the city of Cracow continues to grow.

To understand this dynamic we need to go back to fundamentals. The theory which underlies that relationship between land prices and distance from the city center is based on a number of assumptions about employment, transportation costs and demand for

housing. Many of these assumptions reflect stylized aspects of an economic model which, thought not perfectly representative of reality may not influence the empirical implications of the model even if they were changed or, if changed can yield implications for the model.

In a transforming economy, a number of the key assumptions may not be met. It is necessary to assess some of the assumptions in the context of an evolving economy in transition. For example, the model assumes that there is constant marginal commuting costs, that the price elasticity of demand for housing is equal to –1.0, that there are no public goods or taxes and that there are no zoning restrictions. Relaxation of all of these assumptions have been examined by numerous authors[51] but not usually in the context of a transforming economy. If prior to the transformation, public transportation was free and workers' opportunity costs were low, one of the fundamental assumptions of the model is not met. As the economic transformation evolved, workers' opportunity costs increased and necessary user costs were imposed on public transportation. If prior to the transformation, most housing was subsidized and not allocated by price but rather by other criteria, another of the fundamental assumptions is violated. Price elasticities have little meaning in an environment where goods are not allocated by price. During the time frame under study, a zoning by-law was imposed. Also, the distinction between private and public goods became more distinct and the imposition of an ad valorem property tax was contemplated.

These issues create an agenda for future research. We intend to explore the implications of the relaxation of each of these assumptions in the context of an economy in transformation. Further, we want to explore the role of learning or price discovery in this marketplace. We had expected the explanatory power of the land value function to increase through time as buyers and sellers increased their understanding of the marketplace. This was not the case. In fact, as in other markets, the explanatory power of the land value function declined through time. Presumably, the increasing complexity of the urban landscape and the increasing number of factors influencing value overwhelmed the evidence of any learning or price discovery on the part of market participants. For example, Romer (1993) examines the role the trading process itself has on the evolution of prices. Here, it seems that we should explore the potential impact of the trading process itself as well as improved dissemination of information and enhanced understanding of the role of markets. All of this analysis has to be placed in the context of actual economic events and trends that were occurring in Poland. One cannot interpret the evolution of the land market in a vacuum.

In our analysis, we have include the use of spatial statistics in the creation of the plots of the price surfaces created for the price gradient estimations in Section V. We need to use spatial statistics systematically in our analysis. This is yet another direction in which this work can be expanded. Spatial statistics may provide further insight into the issue of price discovery as one would expect price information to be flow first to owners of nearby parcels.

To facilitate the collection of this type of data, it is imperative to design an inexpensive and easily understood reporting system. The analysis of this data suggest some absolute

musts if creating a useable database is a goal. Along with geo-coding of each parcel, lot dimensions, land use (zoning category), measures of accessibility to infrastructure and measures of the 'quality' of infrastructure are valuable.

One of the steps necessary for enabling these markets to develop fully is the creation of a land market information system facilitated by an ongoing land market monitoring project. This data collection effort should be a component of a much broader real estate market information system that is critical to the development of real estate capital markets. As an example, some issues related to real estate valuation and the development of real estate capital markets in Poland are discussed in Bates et al. (1999).

In summation, the data that has been collected and introduced here offers a great opportunity to better understand the evolution of a land market in transition. It has already improved our understanding, but we have only been able to provide a broad brush perspective on the market. Further analysis of the issues above will provide much greater understanding of the evolution of the market. This effort will be further enhanced by continued updating of the database.

Endnotes

[1] One of the authors, W. J. Brzeski, was involved in the early reforms (1989-1991) and in the late reforms (1997-2000) in the capacity of senior adviser to Deputy Premier and Minister of Finance Leszek Balcerowicz in the area of real estate sector reforms.

[2] Much rural land was not nationalized and peasants retained ownership of their land, although with an increasing level of informality as generations shifted and succession of land possession proceeded without formal registration. Some urban land on the fringes was bought from peasants and developed for private single family housing. In some cities, the prewar owners of housing were never officially expropriated and the old land title "perpetual books" were not eliminated, although few of these owners bothered to record subsequent changes (succession). Their buildings were officially administered by state agencies and tenants were allocated without their consent.

[3] Provided by international institutions such as International Monetary Fund, The World Bank, UN ECE, OECD, as well as bilateral institutions such as the USAID, Know How Fund.

[4] Changes began with amendments to the Constitution, that recognized protection of private property rights, which were defined in the Civil Code and registerable in land title "perpetual books". These rights were then vested in contemporary users, subject to restitution. Much of the state property was transferred to the local governments who could then sell off or lease these assets according to tender procedures. In order to facilitate this process, the real estate appraisal profession was created in the public interest. Later, as privatization and restitution processes led to increased amounts of private real estate, the brokerage and property management professions grew and obtained licensing status.

[5] Leasehold rights, called perpetual usufruct, are registered in land title "perpetual books" and are viewed by many as very close to freehold rights. However, leaseholds are granted only on state or municipal land, can run between 40 and 99 years (with possible extensions), and carry both an initial payment (between 15 and 25 percent of land value) and annual ground rents, which are a fixed percentage of changing land value (which can change every year if the owner wishes).

[6] If the user constructed the building with his or her capital, the building became the property of the user. If not, the user could lease the building or apply for a lease-to-buy plan with a soft financing plan (low interest rate).

[7] It is the deed of conveyance, executed by the notary, that legally passes the title, while the registration in the title registry is a certification.

[8] Appraisers were initially needed for privatization purposes to establish the asking prices at real estate auctions of public property. Brokers developed later as the market began to offer an increasing amount of privatized real estate for sale (predominantly

housing in the form of apartments). Licensing requirements were imposed on appraisers in mid-1990s and selectively on brokers in 2000.

[9] Very high inflation during the initial years precluded any financing, although some interest rate subsidies were offered through dual index mortgage loans. Most of the funds were offered by depository state savings banks. As the inflation rate declined, other banks entered the mortgage market and by the late 1990s mortgage credit became more affordable. Further potential liquidity has been created through the introduction of mortgage banks licensed to issue mortgage bonds.

[10] Usually the reason is that parties have not resolved claims or rightful owners do not want to pay the costs for regularizing their title (re-surveying and registration fees).

[11] This encourages households to save through continuous repayment of mortgage debt.

[12] This approach was applied to the enterprise sector.

[13] Real properties are sometimes comprised of multiple parcels so the number of functional real properties is smaller than 28.7 million.

[14] Data for 1999 are not reported here, but there is a general feeling of weaker market activity.

[15] Allowing sitting residential tenants to buy out the leasehold from the state or municipality.

[16] Often, the final resolution establishes many co-owners, making consensus regarding disposition or management of the asset difficult.

[17] It is widely believed that the majority of land, primarily that in rural areas, still does not have registered title. In many cases, the courts gather “title documentation”, although no title is officially registered. In this way, owner-occupiers can allow “title examination” by interested parties.

[18] This instrument is alternative way of financing existing real estate and absent active mortgage markets serves an important purpose. The leaseholder may still mortgage the lesaehold improvements.

[19] This does not apply to Poland’s territories established on formerly German lands in Western and Northeastern Poland. This applies usually to Jewish properties in Poland’s prewar territories, many of which remain unclaimed, although some have been reclaimed by prior owners or their successors. The State is reluctant to take these properties for non-payment of taxes or the lack of upkeep. Property taxes are, by law, to be paid by owners or, in case they cannot be identified, by users or managers. If there is a missing owner of residential property, the result is that local authorities must

manage the property. While they keep the income, it is often is not sufficient to cover expenses, particularly in case of rent controlled apartments.

[20] Exclusive right to sell is difficult to enforce in Poland, hence the brokers are not keen to share their listings. The traditional view of information as power and competitive advantage makes it difficult for brokers and other real estate professionals to share information in order to stimulate overall market activity.

[21] Tax authorities need to monitor the market in order to control reported prices in notary deeds, which form the basis for transfer taxes (currently at 5% of reported price). Since buyers and sellers are trying to lower these prices in order to minimize the transfer tax, the tax authorities have the right to question the reported price and have appraisal made to establish the market level derived from monitoring of sales.

[22] The land sales data base used in this project comes from the CREI Foundation, which has been monitoring the market as a part of its statutory mission to develop orderly real estate markets. The costs are so high, as discussed later, that only about 30% of expenses are covered through information sales to appraisers and sometimes urban planners. The weak market demands stems from the undeveloped mortgage market (few loans, few appraisals) and non-existence of ad valorem property taxation.

[23] See Bertaud (2000).

[24] Transfer taxes usually take up 5% with another 5% going to the notary fee, registration fee (stamp duty) and broker commission. If case of new properties being built transaction costs are even higher. If a mortgage is taken, which is still not frequent, registration fee of a mortgage constitutes yet another cost.

[25] Which employed in its “best” times some 35,000 people.

[26] Alain Bertaud of the World Bank found in his comparisons, that industrial land does not exceed 10% share in most of the market driven cities.

[27] Alain Bertaud of the World Bank indicates in his comparisons that market driven cities usually exhibit more than 50% for residential uses.

[28] Data on 1999 are not complete. Altogether we have identified 6,101 transactions, which can be seen as arms length for that period.

[29] The Tax Code allowed generous deductions for new housing expenses including land acquisition costs.

[30] Housing completions were: 2,350 (1993); 1,850 (1994); 1,700 (1995); 1,950 (196); 3,350 (1997); 2,500 (1998). The sudden jump in starts is attributable to the introduction of generous tax breaks for purchase of land and housing construction. This constitutes 0.68% to 1.34 % of housing stock, which is a modest level of construction. Actual

housing starts are higher, which should produce higher completions in the coming years.

[31] Completions were slowing down from 94,400 in 1993 to 62,100 in 1996 and after introduction of hefty tax breaks increased to 75,000 presently. This should be compared to the standing stock of some 11 million dwellings (1% annual rate)

[32] Number of dwellings under construction has been steadily rising from 473,800 in 1993 to 640,000 at present. Given the annual completion rate of 75,000 this indicates an average construction cycle of about 12 years which indicates the high inefficiency of the system.

[33] Due to both high mortgage finance costs, still at interest rates of 15% - 20 %, and to tax incentives making it more advantageous to extend construction period, Poland is exhibiting a low volume of housing completions at about 70,000 dwellings annually (as compared to the stock of 11 million dwellings, and a high volume of ongoing construction at about 650,000 dwellings.

[34] Land tax is based on area and has very low rates compared both to the ability to pay and to buildings, see later footnote.

[35] There are about 200,000 land parcels in Cracow, but it should be noted that many real properties are composed of several parcels due to ownership fragmentation, which existed before the War in peripheral areas urbanized during the socialist period and restituted in 1990s.

[36] Floor area ratio or FAR indicates the number of square feet of building that can be developed on each square foot of land averaged over the complete site.

[37] Collection of data at CREI started for parts of 1992, but that period of economic development was very volatile and data not complete. The year 1993 usually is considered marking the end of the initial spontaneous period of radical restructuring of the Polish economy and the beginning of a stable growth path within basic regime of a market economic framework.

[38] The first land value model for mass valuation purposes was developed in 1994 by J. Eckert et al. (1994) using some 600 transactions. The second model was developed in 1996 for research purposes by D. Dale-Johnson and W. J. Brzeski (1997) a little over 2,000 transactions. The third model was again developed for mass valuation purposes in 1999 by J. Eckert et al. (1999) and was based on 6,700 transactions.

[39] For example, the notary has to check whether a foreigner is exempted from government permit to purchase real estate in Poland.

[40] Tax chamber checks the reported prices and may order an appraisal, which can lead to a different price being used as a basis for transfer tax. It has become customary that

parties try to stay within price tolerance used by the tax chambers. A disincentive against this is that municipalities sell land at auctions, which establish price benchmarks. Another disincentive is that tax laws allow generous tax breaks for purchase of land for residential purposes. Another disadvantage is that value gain on successive resale will trigger a higher tax.

[41] Variables *OBR, LOT, SEL, BUY, LHD, P, AREA, DATE* and *LMT*. Transaction dates were transformed into an ordinal variable by assigning dates to one of the 81 months spanning the study period. For variables definitions see Appendix A.

[42] Variables *ELE, GAS, WAT, SEW, HEAT* and *TEL*. For variables definitions see Appendix A

[43] Variable *ZON*. For variables definitions see Appendix A

[44] Variables *RELX, RELY, FRNT, DPTH*. For variables definitions see Appendix A

[45] For the year 1993 site visits produced the following attributes: *ECO, NGH, ACC, BLD, DET, TPT, AME.* For variables definitions see Appendix A.

[46] Variables *DIST, ANGLE, UNITP, RUNITP, USP, USUNITP, RES, COM, IND, AGR, F/D.* For variables definitions see Appendix A.

[47] Binary format contains only Yes (1) or No (0) values (see *LHD, LMT, COM, INT, AGR).* Categorical format contains a variety of selected possible values or symbols (see *SEL, BUY, OBR, LOT, ZON, RES, ELE, GAS, WAT, SEW, HEAT, TEL, ECO, NGH, ACC, BLD, DET, TPT, AME*). Continuous format contains large continuous range of possible values (see *NMB, RELX, RELY, DIST, ANGLE, P, UNITP, RUNITP, USP, USUNITP, AREA, FRNT, DPTH, F/D, DATE)*

[48] *ECO, NGH, ACC, BLD, DET, TPT, AME*

[49] MacDonald (1979) undertakes a thorough study of the evolution of the land price function literature.

[50] A new zoning plan for Cracow was adopted in 1995 and is shown in Figure 2. Bertaud (1999) argues that the plan was driven by the existing land use pattern rather than by the promotion of compactness, one of the expressed goals of the master plan.

[51] Henderson (1977) examined commuting costs; Kau and Sirmans (1979) examined the price elasticity of demand; Epple et al. (1978) examined public goods and property taxes; MacMIllen and MacDonald (1991) examined zoning.

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