THE SIMULTANEOUS EFFECTS OF POSITIVE NET MIGRATION AND RISING HOUSING PRICES IN COLORADO: A CROSS COUNTY TIME SERIES ANALYSIS

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THE SIMULTANEOUS EFFECTS OF POSITIVE NET MIGRATION AND RISING HOUSING PRICES IN COLORADO: A CROSS COUNTY TIME SERIES ANALYSIS

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Abstract

Colorado is one of the fastest growing states by both population size and median housing price. Literature has focused primarily on the determinants of migration and housing prices, however there is an absence of literature that addresses them simultaneously. The primary contribution of this study is to fill some of this gap in methodological approach. An additional contribution of this literature is the provision of analysis of migration/housing dynamics at the county level. We form and estimate via MLE a structural equation model consisting of functional forms for in-migration, out-migration and median housing price and find evidence of a simultaneous relationship, suggesting that earlier findings which examined these effects independently may be biased. Interestingly, we find that an increase in in-migration functions to lower housing prices while an increase in out-migration functions to raise prices. This is not consistent with our expectations or with most of the literature. We also find that a rise in housing prices functions to increase in-migration and decrease out-migration, which is more consistent with our predictions.

KEYWORDS: Migration, Median Housing Prices, SEM, Simultaneous Equations

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Matthew Pesner

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Introduction

Colorado is one of the fastest growing states in America. Between 2001 and 2012, the United States Census Bureau estimates that Colorado had the 9th highest average annual population growth rate of the 50 states and Puerto Rico. If we turn to the period from 2005-2012, Colorado jumps to the 6th highest and if we average from 2008-2012 it moves up to the 5th spot. In short, the 21st century has seen a great concentration of population growth in Colorado, and this rate of growth has been increasing. Using American Community Survey (ACS) 2013 one-year estimates, the Colorado Department of Local Affairs (DOLA) estimates that only 43.35% of people living in Colorado were born there compared to a national average of 58.8%. Here we see that there is also a long-term effect of migration patterns to Colorado. Although the most likely demographic to move is young (Mincer et al., 1979**),** the sheer size of the difference between Colorado and the national average compels us to believe that Colorado has been increasing in population for some time. A population can grow in two ways: through the natural increase in population, the birth rate minus the death rate, and from positive net-migration (NM). NM is defined as the total number of in-migration (IM), the number of people who moved into a given area, minus the total number of out-migration (OM), the number of people who moved from a given area. The natural birth rate tends to be consistent throughout the United States (Potepan 1994). Therefore, natural increase in population doesn't contribute substantially to the variations in population growth rates we see, and we may equate Colorado having a high degree of population growth to Colorado having a high degree of positive NM.

Additionally, Colorado has been experiencing significant growth in its housing market, the degree of which is particularly stark since the Great Recession. According to ACS one-year estimates, between 2009 and 2014, the median house price fell by roughly 2.1% nationally whereas Colorado's median housing price has risen by around 7.3%, see figure 1. Given that Colorado has been experiencing such high rates of NM and housing price appreciation over the past decade, it begs the question of what the relationship is between these two variables.

The issue of migration into Colorado is a particularly salient topic. For decades Denver and El Paso County have opted to spread out than spread up. Urban Sprawl has huge environmental and social costs, including higher energy costs, more traffic and the need for more local amenities such as schools and hospitals (Goetz, 2011). Recently, Denver has been commended for their new "smart-growth" policies towards urban sprawl issues. Denver also has over seven times as many people per municipality as the next highest county, a measure we will take as our proxy for growth controls. It may be that Denver is better equipped to handle these issues than other fast growing counties like El Paso. If we can determine some unbiased causal effect of housing prices on migration and vice versa, this information could be useful to county officials, particularly on their policies towards growth controls, as the flow of migrants to Colorado may continue to rise for some time.

It is intuitive that if the demand for housing in a given area goes up, prices will follow. This is consistent with basic economic theory. Thus if a rise in IM reflects an increase in demand for housing in an area, we may expect there to be a causal relationship between migration and housing prices. Additionally, it also follows that if an individual is going to move to an area, they will consult the local housing prices as one of their key measures to decide whether to move (Saks, 2007). Therefore, we propose that housing prices are endogenous to migration. Most work has focused on one of these directions of causation; either the effect of migration on housing prices or housing prices on migration. Empirical findings from both bodies of literature compel us to expect some type of equilibrium mechanism between these variables. Potepan (1994) conducts a simultaneous analysis and finds significant evidence for simultaneous effects. If we ignore the potential for simultaneity in our estimation, our estimates will be biased due to the fact that in any of our estimations, housing prices or migration are endogenous to the model but treated as exogenous (Wooldridge, 2013). This is the primary contribution of this paper to the literature. Using panel data, we specify and estimate a structural equation model (SEM) consisting of a system of three simultaneous equations, deriving functional expressions for IM, OM and median housing price. We find that there is solid statistical evidence of simultaneity, and interestingly, we find the different coefficients than we had expected and that Potepan found in his 1994 analysis. We will discuss our expectations for signs of coefficients in the theory section.

Another main contribution that this paper makes to the literature is that it focuses on smaller locals than most previous work. Most work has used data on metropolitan statistical areas (MSA's) because good data on migration, housing prices and a number of other variables thought to determine migration and housing prices has been available. This study looks at the county level, and its viability has been contingent upon the American Community Survey (ACS), which has been providing intercensal estimates of a number of population, demographic and housing characteristics since its inception in 2005. Theoretically, this also allows us to consider that both time variant and invariant location specific effects have a higher degree of homogeneity throughout our sample then previous studies which looked at MSA's dispersed across the county. This is important since amenities are the hardest of our variables to get a good measure for.

Interestingly, we find a negative causal relationship between IM and price, while at the same time a positive causal effect of OM. This is contradictory to our hypothesis, however it may be that this is representative of a cyclical effect due to the contraction in the economy in 2008. We find that a rise in prices will attract further IM, consistent with Knapp (1989), as well as function to detract further OM.

Outline

The remainder of the paper will be organized as follows: A synopsis of the basic economic theory behind migration/housing dynamics will be provided and lead us to our expectations for signs and magnitudes of coefficients. This section will include a good deal of the literature review, because it is necessary to place the theory within the context of empirical findings. Following will be a brief description of additional previous related literature not covered in the theory section. Next will come a description of the data and sources, including the benefits and limitations. We will then present our methodology, including the derivation of our empirical structural equation model (SEM), justification of specifications and a description of estimation techniques employed and why. Following will be a discussion of the evidence for the presence of simultaneity, what we can glean from statistical tests for endogeneity as well as the sign and significance of our results and key findings. The paper will then conclude, and discuss whether or not there are justified policy implications from our results.

Economic Theory

The first body of economic theory discussed here is how we may expect housing prices to effect IM and OM individually. Following, we will provide some theoretical background of how we may expect IM to effect housing prices. There is strong empirical evidence supporting a positive causal effect from IM to housing prices, however there is also contradictory evidence that must be outlined. We then review what economic theory lead us to believe will be the effect of OM on housing prices. Finally, we turn to an analysis of how we expect these three processes to interact simultaneously.

Economic theory motivates us to expect that an individual's decision to move will be based off of differences in wages, housing costs and amenities between areas. (Platinga et al., 2012). When focusing on the role of housing costs, we expect that housing prices influence an individual's decision to move to a given local through two main effects (Potepan, 1994; Graves, 1983). Historically, higher housing prices and been considered to reflect higher shelter costs and as such are expected to discourage IM. Logically this follows as higher housing prices will segment a larger proportion from the population that can afford to move to a given local. However, as graves (1983) argues, higher housing prices also reflect a greater degree of local amenities and as such we might expect higher housing prices to encourage IM. By accounting for simultaneity, we will see that we can view the choice an individual makes to move as having already factored into their decision local housing prices and as such has already taken into account shelter costs and amenities. Which of these effects dominate, higher shelter costs or higher amenities, is an empirical question. Graves (1983) finds that amenity effects dominate. However, Gabriel et al. (1993) and Hyclak (1999) found shelter effects to dominate. Using an original methodological approach with respect to the computation of a measure for housing prices, Platinga et el. (2012) find empirical results consistent with their prediction of the domination of shelter cost effects. However, when using median housing price, average apartment rent and average urban land rent separately as the dependent variable instead, they find a positive effect of housing prices on an individual's decision to move to an area. In short, there are many contradictory findings on this topic. Because we include measures for local amenities, and because of the theoretical validity of shelter cost domination, we expect that higher housing prices will function to have a negative effect on the decision to move somewhere; ie. on IM. Similarly, we extend this concept and expect that if housing prices decrease it will encourage further IM.

When discussing the effect of housing prices on OM, the economic theory is a bit more nuanced. If prices go up in an area, there may be a few reasons to think that there will be a decrease in OM. Sjaastad (1962) presents the following simple equation to express the individual's decision to move:

$$NPVM_{i,j,o} = \sum_{t=1}^{T} \frac{\beta_j - \beta_i}{(1+r)^t} - \sum_{t=1}^{T} \frac{C_j - C_i}{(1+r)^t} \tag{1}$$

Where NPVM is the net present value of migration, βj and Cj are the benefit and cost associated with your current location and βi and Ci are the benefit and cost associated with your potential destination. Gabriel et al. (1992) also utilizes this same idea. If an individual's net benefit is higher for somewhere else than their current location they will move and if it is less than or equal to zero, they won't. They argue there are three big factors that influence an individual's choice to move. They are economic opportunities, local amenities and the cost of migration. If the value of an individual's home rises, this implies that βi goes up through the benefit of more value in their home or the benefit that their value reflects through amenities. This will cause the NVPM to decrease and cause an individual to be less likely to move. We may provide the identical analysis of home appreciation through the framework of a trade off between shelter costs and amenities. If shelter costs don't change for the individual who already owns their home but their value increases, this may reflect increased local amenities causing the individual to be less likely to leave. An additional point pertains to expectations. As people gain equity in their homes they may harbor expectations about future appreciation and opt to stay where they are as they expect further valuation. Although there are some contradictory ideas, we expect a rise in housing prices to decrease OM.

We must be cautious when trying to extend this relationship to the case where housing prices enter into a period of negative growth. We cannot simply extrapolate and claim that a drop in housing prices would cause individuals to leave, whether due to a loss in amenities or expectations of further devaluation. This hypothesis assumes nothing about the individual's ability to migrate. For people who have lost significant equity in their homes, they may be underwater on their mortgage and therefore unwilling or unable to relocate, regardless of the economic opportunities in other areas. This is what is known as the "house-lock" effect. The NBER (2011) finds that this effect is not responsible for the long-term shift in migration dynamics in the United States. It may be that it has an effect in our short-term analysis, but for now all we do is note it.

We interpret the effect of IM on prices through a simple supply and demand mechanism. We expect that if more individuals move to an area, housing prices will respond by going up through the expectation that further people will move to the area, further increasing housing prices (Potepan 1994). Empirical results support that there is a positive effect of population growth on housing prices. Manning (1989) and Potepan (1993) found that population growth has a positive effect on housing prices. As noted earlier when comparing variations in growth in housing prices we need only address NM. Potepan (1994) utilizes this substitution of IM and OM for population growth and finds a positive coefficient for IM and a negative coefficient for OM. When combined, results suggest that a 10% increase in NM functions to increase housing prices by 4%.

Of particular interest in this study is not only the sign of our coefficients of interest, but also their magnitudes. Although we expect that a greater degree of IM will result in higher housing prices across counties, there is reason to think that the effect of IM on prices varies dramatically between counties. Vermulen et al. (2010) find very significant effects of residential development constraints on housing prices. Saks (2007) finds empirical evidence supporting this idea. If a local has a higher degree of construction constraints, a rise in demand for housing will reflect a higher increase in housing prices relative an area with lower growth controls. Essentially, higher construction constraints lead to higher price elasticity of demand. Saks (2007) compiled an extensive index on the variations in construction constraints between MSA's. Although we do not have access to such precise data on county level construction constraints, following (Potepan, 1994; Ozanne and Thibodeau, 1983; Fortura and Kushner 1986; Manning, 1989; Rose ,1989; and Henderscott and Thibodeau, 1990), we use the number of municipalities per 1000 individuals in a county as a proxy for construction constraints. The idea is that a lower number of more-centralized governments will be more effective at designing growth controls aimed at appeasing local homeowners who are interest in having their houses appreciate.

We predict that higher OM will have a negative impact on housing prices. If people are moving away from an area, there must be a reason why. Referring back to the simple microeconomic model of the individual's decision to move, there has been some change in the cost/benefit relationship that has caused them to view moving as the best option. Although there is significant heterogeneity between different individuals inputs when they decide to move (Etzo 2008), there are some primary factors that are more homogenous between individuals.

Notice that we predict negative coefficients for the effect of median housing price on both IM and OM. What will be of interest is a comparison of their magnitudes because it will allow us to infer the effect of housing prices on population growth. We expect that a rise in housing prices will decrease IM further than OM, functioning to decrease NM and therefore population growth. We also expect that IM and OM will have opposite signed coefficients in their effect on housing prices.

Literature Review

Much of the literature consulted for this study was already introduced as a means by which to augment the economic theory and lead us to our expectations for coefficients. Some historical context of internal migration dynamics in the United States is provided here. The United States has one of the highest rates of internal migration of the developed countries (NBER, 2011; Bell, 2015). It is estimated that between 1900 and 1980, migration was steadily increasing. Since then there has been a shift in this dynamic on a national level. It is because this decline is pervasive through demographics and areas that the NBER believes it is a structural and not cyclical changes. This makes Colorado all the more interesting as a case study, because it is characterized by the reverse trend as is the nation. This has important ramifications for a traditionally low population state such as Colorado. It may be that over the next 50 years Colorado becomes a much more important economic center for the United States than it previously was. This is why it is important to examine growth methodology as (Goetz, 2011) does.

Much of the chronicling of migration studies has been presented through Greenwood's 1985 and subsequent 1997 surveys of the literature. Since the 1997 survey, the NBER has taken up the fifteen years in between. Evans (1990) also gives an overview of a lot of literature with a primary focus on equilibrium. Much of the primary research on migration that we have referenced in the theory section is presented in these overviews.

In the literature, theory on migration is broken up into micro and macro economic principles (Etzo, 2008; Sjaastad, 1962). The equation presented in the theory section on the cost benefit relationship is an example of the micro approach, while deriving aggregate flows of IM and OM via labor market opportunity measures such as the unemployment rate or the labor force participation rate is an example of the macro approach.

Our methodological approach is founded in the following work: (Potepan, 1993; Potepan, 1994; Gabriel et al 1992; Saks 2007). We will discuss their works in further detail in the proceeding sections.

Data

This research is contingent upon the fact that good data has been made available in recent years on IM, OM and median housing prices at the county level. The American Community Survey (ACS) is the primary source of data utilized in this study; all data except for IM and OM come from the ACS. The purpose of the ACS is to attempt to provide us with information typically gathered in the Census between census years. Since it's inception in 2005, the ACS has developed one-year, three-year and five-year averages on a variety of measures relating to housing and population characteristics. Due to certain limitations of both the five and one year estimates, our data set is composed of two time periods containing three-year averages, available for the twenty-five counties whose population is greater than 20,000 between 2005 and 2010. Migration data is pulled from the Internal Revenue Service (IRS) Statistics of Income (SOI) department devoted to producing migration data. The data provided by the IRS on migration is of one-year estimates, so to be consistent with the rest of our data, simple three-year averages of IM and OM and computed. With one more year of data, we will be able to extend the analysis to three time periods. Because the methodology employed will be the same and the data will be available, it will be very simple to extend the analysis. Still, our two period sample gives us the ability to make some inference about the dynamics between IM, OM and housing prices.

As stated, our sample consists of all counties whose population exceeds 20,000. This implies that our sample is representative of at least 85% of the population of Colorado, and most likely closer to 90%. A detailed description of exactly which variables are taken from the ACS is provided in the methodology. As mentioned, one of the greatest strengths of the ACS is that it provides us with census data between census years (2000, 2010, etc.) on financial, demographic and housing characteristics. Without this data, an analysis of locals of this size would not be possible. This is the reason that most previous research has focused on MSA's and not at the county level. Because our inference is all in one state, we expect that omitting as accurate a measure of amenity values is less significant as there are state specific amenities common to all counties.

The source for the migration data utilized is provided by the IRS SOI migration division. There are a few facts and limitations of the data that must be addressed. IRS migration data is computed by comparing consecutive tax returns and determining if they are filed from different locations, in this case different counties. Taxes are generally filed in the proceeding year from the year of that income was earned. This means the "filing year" or given migration year is almost always one year following the "tax year", or the year of income earned (Gross, NA). Therefore, because we are interested in the simultaneous effects of migration and housing prices, we must match IRS SOI data on IM and OM with data for the rest of our variables from the previous year. We compute averages of 2006-2008 and 2009-2011 and as soon as migration data for 2013-2014 is released, which according to the IRS, "should be shortly", we will include the time period 2012-2013.

There are a few reasons to believe that IRS estimates are biased downward for both IM and OM, and particularly for IM. The most substantial shortcoming of IRS IM and OM data is that it does not account for illegal immigration. According to the Pew Hispanic Center, as of 2011 Hispanics composed 21% of the population of Colorado, the 8th highest percentage in the country. In addition, as of 2012, they estimate that unauthorized immigrants composed 4.7% of the workforce. Given what we know about the share of Colorado's population that is Hispanic, the magnitude of flows of illegal immigrants into the United States from Latin America and the proximity of Colorado to the Mexican boarder, there is reason to think that there is a positive population increase due to inflow of illegal immigrants into Colorado that is not captured by IRS data. This is why we expect IM figures to be the most biased downward. We may expect this idea to bias OM downward as well through undocumented outflows of illegal immigrants, but not to the same degree as IM**.** The second reason is that IRS migration data comes from filings submitted before the end of the 39th calendar week (late September). All other later filings are omitted from the figures. The IRS estimates that the figures obtained through Cycle 39 represents between 95-98% of all returns filed during any given year, so between 2-5% is the estimated level of downward bias related to this component of IRS methodology. Therefore, we expect that IRS data understate the NM figures.

The Colorado State Demography Office provides their own estimates of county level NM. Beginning with IRS NM estimates, they make a number of changes based on their own more locally specific data. One example of a change made to IRS NM figures is provided via a personal anecdote concerning group quarters from a Colorado state demographer. One year a large state prison was closed in Adams County and the prisoners were moved to other prisons around Colorado. The IRS was not aware of this closing and failed to include the relocation of these prisoners to other counties in their OM estimate that year. In this case, OM was biased downward. Still, in their survey of internal migration in the United States, Molloy et al. (2011) of the National Bureau of Economic Research (NBER) corroborate the accuracy of IRS measurements of IM and OM above or equal to all other measures available to us.

Methodology

The primary source for the specifications of our empirical model, as well as our methodological approach, comes from Potepan (1994). Looking at a cross-section of 52 Metropolitan Statistical Areas (MSA's), Potepan forms a SEM and employs a simultaneous equations framework between functional forms for IM, OM and housing prices. In his model, median housing price is a function of IM, OM as well as controls. Separate equations of IM and OM are specified as functions of the median housing price and identical controls, and these three equations are estimated simultaneously. In our model, a similar framework is utilized and we form a SEM between IM, OM and housing prices. The primary difference in our model is that we include a dynamic component. In doing so and running a simultaneous analysis with fixed effects, we automatically account for location specific, time-invariant effects.

The model specification for housing price is primarily derived from economic theory and is adjusted from that which was originally presented by Ozanne et al. (1983) and later adopted by Potepan (1994). A similar model is also used in Gabriel et al. (1992). Our derivation of our functional form for median housing price is the following:

$$HD_{it} = \theta_0 + \theta_1 P_{it} + \theta_2 N^*_{it} + \Omega'_D X_D + \mu_{it} \tag{2}$$

$$HS_{it} = \eta_0 + \eta_1 P_{it} + \eta_2 N^*_{it} + \Omega'_S X_S + \tau_{it} \tag{3}$$

$$P_{it} = \beta_0 + \beta_1 IM_{it} + \beta_2 OM_{it} + \Omega'_p X_P + \epsilon_{it} \tag{4}$$

$$\text{Where:} \quad \epsilon_{it} = \xi_i + \zeta_{it}$$

Housing price is derived from defining housing demand and supply functions, and solving for the equilibrium price of housing. Typical exogenous variables include median household income, local property taxes, the population level, population growth rate, price of housing services, median contract rent and many types of location specific amenities. Because of the aforementioned argument concerning the natural population growth rate between various counties we may substitute in our data for IM and OM for the population growth rate N* if we assume a linear relationship between them. Local property taxes are calculated using a ratio of median real estate taxes paid to median housing price for an accurate cross comparison. Median monthly housing costs divided by the median housing price are used as a measure for the price of housing services. We decompose the error term into time variant and invariant effects. One of the largest benefits gained from using a dynamic panel set as opposed to cross sectional is that we can control for the time-invariant aspects. In doing so, things like natural beauty, air quality, distance to coasts and other qualities that do not typically vary with the amount of time we are concerned with, are controlled for. In addition, following Knapp et al. (1989), we use median contract rent as a measure for local amenities. Further local amenities are thought to be captured into the housing prices themselves (Graves 1983), thus by including housing prices as endogenous to migration, we account for the individuals perception of local amenities as well.

Following Potepan (1994), we define our IM and OM equations as functions of identical variables, including controls and median housing price; we expect, of course, to estimate different values for the coefficients:

$$IM_{it} = \alpha_0 + \alpha_1 P_{it} + \Omega'_{IM} X_M + \mu_{it} \tag{5}$$

$$OM_{it} = \delta_0 + \delta_1 P_{it} + \Omega'_{OM} X_M + z_{it} \tag{6}$$

Where: $\mu_{it} = \xi_i + \zeta_{it}$ and $z_{it} = \phi_i + \omega_{it}$

The exogenous variables included in our migration equations are: Housing Prices, two measures for employment, including the unemployment rate and the labor force participation rate as well as median contract rent. Here, the measures of employment aim to capture labor market opportunities and median contract rent again attempts to capture local amenities. Theoretically, housing prices serve to capture amenities as well. Finally, we include dummies for the 9 regions of Colorado and quartiles for rural percentages of counties separately and estimate Random Effects analysis to attempt to capture any regional-specific effects at play.

We form a SEM where there are dual direction relationships between housing prices and both IM and OM. Equations (4) (5) and (6) form a system of three simultaneous equations:

$$P_{it} = \beta_0 + \beta_1 IM_{it} + \beta_2 OM_{it} + \Omega_p' X_P + \epsilon_{it} \quad (7)$$

$$IM_{it} = \alpha_0 + \alpha_1 P_{it} + \Omega_{IM}' X_M + \mu_{it} \quad (8)$$

$$OM_{it} = \delta_0 + \delta_1 P_{it} + \Omega_{OM}' X_M + z_{it} \quad (9)$$

We estimate the system using MLE. The system of equations is over identified according to its order and rank conditions. The main methodological approach is that if we can measure the simultaneous marginal effects of IM on housing prices and housing prices on IM while also estimating the marginal effects of OM on housing prices and housing prices on OM, we can infer about the sign of the effect of housing prices on NM and vice versa, which is what we are primarily concerned with. Determining this marginal effect will determine the sign of dynamics between population growth and housing prices. We expect a positive relationship. The advantage of this methodology from using simply net-migration figures in a simultaneous analysis is that we are able to differentiate between counties who may have vastly different sized IM and OM flows but similarly sized NM flows. We estimate a simultaneous relationship between NM and housing prices and find much less significance than with our three-equation model.
We also provide estimations that do not account for simultaneity. We estimate three separate equations using OLS and also provide and instrumental variables analysis using 2SLS estimation for comparison purposes.

Results

The further we restrict our model specification, the higher the significance of our estimations. For example, if we include variables such as median contract rent and vacancies over units in structure, although economic theory tells us that these variables should have an impact in the housing demand and supply equations, and therefore have an effect on housing prices through our derivation from equilibrium supply and demand, our model becomes much less efficient. We should not be surprised by this cause of inefficiency. As noted earlier, the sample size is small and thus trying to estimate over 8 variables leads to inefficient coefficients. This is true across estimation techniques; more specified models raise the inefficiency very quickly, which may not be the case with a more observations. Therefore, the only model specification included here is where price is a function of only IM, OM, median income and median contract rent over price and the migration equations are functions of only the median housing price, population, unemployment rate, median contract rent over price and vacancies over units in structure. There are some pretty interesting results and signs of coefficients. The system is still identified according to its rank and order conditions. In addition, we estimate a random effects regression to determine if location specific effects are present. Again we run into issues of inefficiency and insignificance, and thus these analyses are omitted as well.

We find very little significance for our coefficients when using OLS as our estimation technique across model specifications. Three independent OLS estimations are computed and compared with other estimation techniques, accounting for the four directions employed in the SEM (IM → P, P → IM, OM → P, P → OM). Table 1 shows our results from OLS, 2SLS instrumental variable and MLE SEM estimations. Although we employed the most reduced-form specification for our model, as can be seen on Table 1, not a single one of our estimates was significant above the 85% level and nothing could be said about the estimates for housing price and IM above the 70% level. Due to the size of our standard errors, it is difficult to draw inference from our OLS estimates. Either they are biased due to simultaneity, or the variables I am using have no explanatory power on each other. This paper has outlined the economic theory behind why we should think that the first of these is the issue and not the second. The signs of the coefficients are consistent with those estimated using instrumental variables through 2SLS estimation and structural equation modeling through MLE; they are just less efficient. We will discuss these coefficients and our interpretation of them following a discussion of alternative estimation methods and statistical tests.

We followed our OLS estimations by estimating our model using our IM/OM equations as instruments in our price equation. We find similar signs of coefficients and a similarly large degree of inefficiency. Using instrumental variable analysis estimated through 2SLS, we cannot make any inference about the marginal effects of these variables on one another, as is the case with OLS. Corroborating the lack of efficiency gains from instrumental variable analysis over OLS, hausman tests for endogeneity between all three OLS and both 2SLS estimations do not show evidence for endogeneity (Hausman, 1978). The reader should be cautious to interpret this test result as meaning there is a lack of simultaneity; as will be demonstrated, there are many efficiency gains across variables from estimating an SEM by MLE that we believe are resultant of addressing simultaneity bias. Additionally, the hausman test as well as other statistical tests are always in-sample tests and therefore are subject to the same limitations as is the rest of our inference. Because the hausman test is inconclusive, all we may say is that we fail to reject the null that there is no systematic variability between the two estimation techniques. Since there is an efficiency bias trade off between OLS and IV estimation techniques, and because we have little information concerning the degree of endogeneity bias, we do not have the ability to assert that one estimate is preferable to the other in this case (Wooldridge, 2013). We may still use economic theory to lead us to expect that there is simultaneity bias, but that is all we know when comparing OLS and 2SLS. Fortunately, the SEM MLE approach gives us much more consistent and efficient results than either OLS or 2SLS, as seen in table 1, so which is better is a question that may be omitted in this analysis in favor of solely referring to our SEM estimates for our primary inference.

We turn to a MLE estimation of these variables simultaneously. Across specifications, many of the coefficients are significant, often at the 99% level. SEM follows the same pattern of the other estimation techniques regarding less efficient coefficients the more variables we include, so we run the same reduced form SEM and provide some analysis here solely on that specification. Hausman tests are inconclusive between all separate estimation methods. However, the combination of such high efficiency gains and our theoretical expectation of simultaneity bias leads us to believe that these estimates are the only of the three that do not suffer from simultaneity bias.

We now turn to the specific results and some reasons why we may think we find the signs and magnitudes that we do, both theoretical and empirical. SEM's provide us with information not only on the direct effects of explanatory variables, as with OLS and IV analysis, but also with the indirect effects. The sum of these two provide us with our measure for total effects. It turns out that the signs for coefficients in both the direct and total effects are all the same, but there is significant variation in magnitude and statistical significance. We will discuss first the direct effects and then what total effects we find from incorporating indirect effects. All of our findings for direct effects were significant at the 99% level except for the effect of prices on OM, which was significant around the 85% level.

The most interesting coefficient we found was a negative sign for the direct effect of IM on housing prices across estimation techniques. This should come as a bit of a surprise, because this implies that an influx of individuals moving to a region causes shelter costs to decrease. There are a few reasons why this may be the case. First, our model attempted to account for the structural break in the housing market caused by the Great Recession by including a dummy for observations in the second time period. However, we did not find any significant effect and the inclusion of this dummy contributed to less efficient estimates so we omitted it from this analysis. This indicates that the coefficient we have found for IM may be representing a cyclical effect of the housing market on housing prices and not the long-term dynamics between housing prices and migration (NBER, 2011). The second reason has to do with expectations. As stated earlier, Colorado has been experiencing higher positive NM than almost all other states for most years of the 21st century. On the supply side, housing markets were most likely responding to this increase in IM and when the recession hit and labor market opportunities fell through, this glut in supply caused prices to go down. We will see what effect adding one more time period of data has on this analysis. This is particularly salient because the newly incorporated three-year period will be the first period we have access to after 2008-2010, which encompasses the bust in the housing market, and also because housing prices have rebounded in Colorado much quicker than the national average, see Figure 1.

Turning now to the direct effects of OM on housing prices, we found that it had an almost equivalent magnitude as IM, except positive. We believe that this reflects both the recession and the "house-lock" effect, as housing prices and OM decreased simultaneously. We also found that there is a positive direct effect of housing prices on IM. If we view this effect within the context of amenities and shelter costs, our findings are consistent with Graves (1983), namely, that amenity effects dominate.

Finally, we find that that there is a negative direct effect of housing prices on OM. Theoretically, this might support our hypothesis of expectations regarding future increases in housing equity. It also supports the idea of a shift in the cost/benefit expression for NPVM introduced by Sjaastad (1962). If individuals expect that their houses are going to keep rising in value, they may be less compelled to leave. We can also view this under the shelter cost amenity framework. If we expect that housing prices reflect amenities, and shelter costs are already sunk for the individual who lives in an area, then their perceived amenities will increase relative to shelter costs, causing their cost/benefit analysis of moving to favor their current local even further.

We find that total effects mirror signs of coefficients for all variables of interest, however their magnitudes are all dampened by the alternative signs of the indirect effects. Strict interpretation of our direct effects would imply that an increase of one migrant moving into an area decreases the median housing price by over $40. This is far from realistic. The total effect for this measure would imply that prices would fall by slightly over $4. This is still hard to believe, but it is more believable than $40 direct. Similarly, the positive total effect of IM on housing prices, the positive total effect of housing prices on IM and the negative total effect of housing prices on OM are all of smaller magnitude.

Conclusion

There has been much literature that has focused on the determinants of migration and housing prices. In both bodies, the other variable is often employed as an explanatory exogenous variable. Most of this literature has also focused on looking at Metropolitan Statistical Areas, as those are the only areas where good data has been available. This study fills some of these gaps by examining migration housing price dynamics simultaneously and at the county level. We investigate the degree to which housing prices and migration are simultaneously determined by attempting to estimate our model via more ordinary methods that do not account for simultaneity. To that end, we provide significant theoretical and empirical evidence for the presence of simultaneity. Although the coefficients we find are unique and most likely reflecting cyclical phenomena, the evidence of simultaneity is strong and leaves this subject open for further work. As the American Community Survey gains more tenure, this type of analysis will become more and more realistic to conduct.

This analysis has important implications for Colorado in particular, as it is one of the fastest growing states, both my population and housing price. As stated in the introduction, there is significant worry concerning issues related to urban sprawl in Denver and El Paso County, as well as others. Because there is so much land in Colorado, in the past these cities have opted to spread out rather than up. There are considerable societal and environmental costs to urban sprawl issues. Goetz (2011) commends Denver on their “smart-growth” policy towards the vast positive inflows of NM they are facing. Through further understanding of the dynamics between housing prices and migration, these counties will be able to better prepare themselves for future in flows of migration.

Figure 1

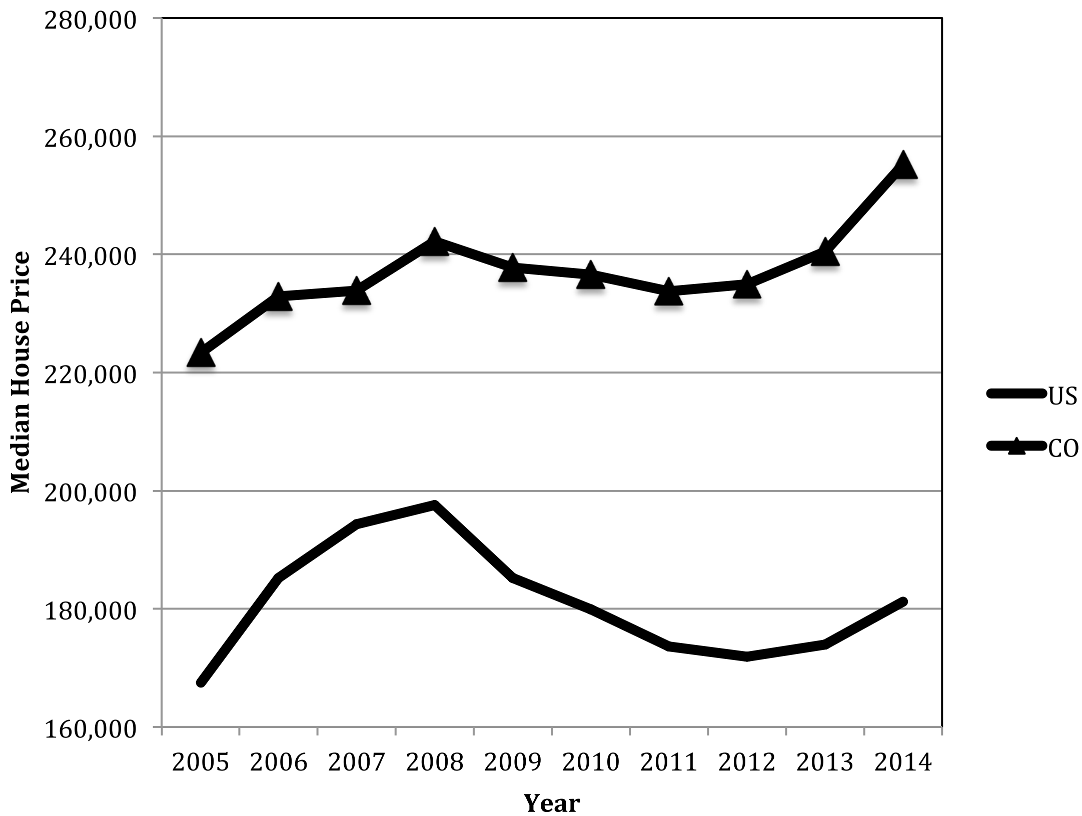
280,000
260,000
240,000
220,000
200,000
180,000
160,000
Median House Price
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
US
CO

Table 1

Endogenous

Exogenous	OLS: *Median Housing Price*	OLS: *In-Migration*	OLS: *Out-Migration*	IV 2SLS: *Median Housing Price*	IV 2SLS: *In-Migration*	IV 2SLS: *Out-Migration*	SEM MLE: *Median Housing Price*	SEM MLE: *In-Migration*	SEM MLE: *Out-Migration*
Median Housing Price		-0.014	0.022	-	-0.014	0.022*	-	0.134***	-0.077*
	-	(0.036)	(0.015)	-	(0.036)	(0.015)	-	(0.0580)	(0.054)
In-Migration	-1.016	-	-	-0.271	-	-	-45.544***	-	-
	(3.116)	-	-	(2.266)	-	-	(13.648)	-	-
Out-Migration	7.025	-	-	3.79321	-	-	46.649***	-	-
	(6.835)	-	-	(4.764)	-	-	(14.245)	-	-

Note: *significant at 15%; **significant at 5%; ***significant at 1%. standard Errors in parenthesis.

Table 2

<u>Endogenous</u>

	Direct Effects			Indirect Effects			Total Effects		
	Median Housing Price	*In-Migration*	*Out-Migration*	*Median Housing Price*	*In-Migration*	*Out-Migration*	*Median Housing Price*	*In-Migration*	*Out-Migration*
Median Housing Price	-	0.134***	-0.077*	-0.907***	-0.122***	0.070***	-0.907***	0.012	-0.007
	-	(0.0580)	(0.054)	(0.147)	(0.019)	(0.011)	(0.147)	(0.053)	(0.052)
In-Migration	-45.544***	-	-	41.318***	-0.569***	0.329***	-4.226***	-0.569***	0.329***
	(13.648)	-	-	(12.381)	(0.170)	(0.098)	(1.266)	(0.170)	(0.098)
Out-Migration	46.649***	-	-	-42.320***	0.583***	-0.337***	4.328 ***	0.583***	-0.337***
	(14.245)	-	-	(12.923)	(0.178)	(0.103)	(1.321)	(0.178)	(0.103)

Note: *significant at 15%; **significant at 5%; ***significant at 1%. Standard errors in parenthesis.

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