

# PREDICTING THE FREQUENCY AND DEPRECIATION IN REAL ESTATE ASSESSMENT QUALITY IN PENNSYLVANIA: 1988-2008

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## INTRODUCTION

IN THE UNITED STATES, THE REAL ESTATE TAX continues to be the most important own-source local tax revenue. As a consequence, there is a vast practitioner literature about how a local real estate tax can be administered most fairly and inexpensively. The International Association of Assessing Officers (IAAO) has promulgated manuals, training, standards of practice, and statutory language that define and enable best assessment practice (IAAO, 2009). Until 1982, the Governments Division of the U.S. Census Bureau measured and reported the quality of residential property assessment by metropolitan area and state (National Academies, 2007; Strauss, 2009). Beyond these two important research enterprises, other public finance researchers have explored a wide variety of questions about the valuation mechanism that underlies application of local real estate taxation.

For example, many researchers have examined how the characteristics of assessors affect the quality of assessment outcomes, while relatively few have addressed why and when reassessment is pursued (See Mikesell, 1979, 1981, 2004; Strauss & Sullivan, 1998; Ross, 2011; Krupa, 2012). Anecdotal evidence suggests that when elected officials choose or are forced to reassess (by the courts, state oversight agencies, or other authoritative bodies), voters who have been negatively impacted by the recalibration of payment for public services will actively remove these politicians and their party from power. Of what does exist, most of the literature concerning the timing of reassessment discusses political pressure issues and the short- and long-term budgetary benefits of reassessment.

Bloom and Ladd (1982) hypothesize that government has an information advantage over taxpayer-voters. Using data from Massachusetts, they found a strong, short-term positive relation between property tax revenues and reassessment in the years following reassessment. In some communities, this relationship was present even in the reassessment year itself. Even though nominal millages were reduced after reassessment, they

found higher effective tax burdens in the median term. Walden and Denaux (2002) in North Carolina found that the growth of property tax revenues was highest in the years immediately following the reassessment. However, during the reassessment cycle, effective property tax rates decreased even if nominal tax rates set by law increased; this in turn gave rise to an increasing gap between potential property tax revenue and actual collections over the reassessment cycle. This gap was interpreted as the motivation behind local government officials' decision to reassess.

In order to link reassessment to the use of property taxes, Strumpf (1999) constructed a model of community-wide reassessment lags and property tax revenues. He suggested that the longevity of a particular property tax reassessment reflected rational, local public choices intending to increase property tax base and tax revenues. Strumpf concluded that short lags between community-wide reassessment resulted in higher tax revenues while longer lags between reassessments led to lower tax revenues. He also suggested that local governments inside a county pressure county officials to reassess in order to shirk millage decision themselves.

In addition to these local public choice considerations, some researchers examine other variables that may influence the reassessment decision. Stine (2005) used a logit model to explain the relation between tax rate limits and reassessment. He conjectured that many Pennsylvania counties tend to reassess the property tax base to increase the assessment ratio if the millage was over the legal limits, thereby using reassessment to avoid millages above their statutory maximums. Stine argued that local governments can obscure property tax growth by reassessing. Unlike previous studies that solely examine limits on fiscal behavior, he strengthened the budget maximization hypothesis that public expenditure growth is positively associated with the probability of reassessment. Stine (2010) also investigated the determinants of Pennsylvania property reassessment duration between 1982 and 2006 using a logit model. Because there is not a strong influence from the commonwealth's govern-

ment or a requirement for periodic reassessment, the duration of reassessment decision is determined by whether enough local revenue has been generated by current assessed values. He concluded that a lower level of expenditures and business growth tended to decrease duration.

Some studies also focus on problems of equity during the process of property assessment. For example, Strauss and Sullivan (1998) explored state-by-state assessment quality data from the Census Bureau and found that states with county assessment systems and elected assessors had lower coefficients of dispersion than other forms of assessment organization. Ross (2012) examined possible institutional determinants of vertical equity in property assessment using data from Virginia cities and counties between 2001 and 2007. He concluded that different assessment practices between jurisdictions are important determinants of vertical inequity.

The real estate assessment decision in Pennsylvania is particularly interesting, because Pennsylvania is among eight states that do not require periodic reassessment. Like Stine (2010), we seek to model this decision to reassess, to examine whether or not recently observed inequities in assessment results lead to greater likelihood of reassessment, and also to determine the impact of reassessment on the resulting fairness of assessment quality. Since 1986, Pennsylvania has changed the basis of property tax appeals so that an appellant may use actual assessment ratios if the disparity between the nominal ratio and the actual ratio falls outside a range of .85 to 1.15. In the empirical investigation below, we examine whether the decision to reassess is not only driven by equity concerns (e.g. historical coefficients of dispersion), but also by the desire to avoid mass appeals by those falling outside of this range, and by the desire for increased revenues to fund rising demand for public services.

By way of summary, we find that forestalling appeals and responding to inequities are the primary determinants of the decision. Furthermore, it is the financial position of governments and school districts in a county that affect the decision to reassess rather than pressures for more short-term or long-term revenues.

The paper is organized as follows: section 2 provides some institutional background about some statutes and definitions that are used when explaining the decision to reassess; section 3 discusses the data and econometric models; section 4 provides

and interprets the empirical results, and section 5 concludes.

### PENNSYLVANIA ASSESSMENT RULES AND NOMENCLATURE

Pennsylvania assigns administrative and financial responsibility for real estate assessment to each of its 66 county governments and to the government of Philadelphia City-County. Countywide reassessment can be conducted in Pennsylvania either by changing the established predetermined ratio<sup>1</sup> (PDR) or by revaluating all property within a county via “a determination of market value including a review of recent transfer of real estate within the neighboring area, a visual inspection of the exterior appearance of the property in question, and a correlation of any other factors that may affect the valuation of the real estate.”<sup>2</sup> The board of assessment appeals is appointed by elected county commissioners, or elected county home rule officials, and formally decides whether or not to reassess all parcels within that county. The county government finances countywide reassessment. Up until 2006, neither form of reassessment required a reduction in millage by any taxing body (the county itself, and municipalities and school districts within said county) to achieve revenue neutrality or limited growth in property tax revenues.

In 1986, Pennsylvania enacted two pieces of legislation that significantly influenced the application of the State Tax Equalization Board’s estimate of the effective assessment ratio during the appeals process. The two acts relate to different classes of counties (Goodman & Varner, 2012).<sup>3</sup> Act No. 1986-194 requires the county appeals board to hear assessment appeals after determining the market value of the property if the common level ratio<sup>4</sup> (CLR) published by The State Tax Equalization Board (STEB) differs from the predetermined ratio (PDR) by more than 15 percent; if so the board is supposed to apply the respective common level ratio to the corresponding market value of the property.<sup>5</sup> Under these statutes, the board of assessment applies the percentage change between the existing predetermined ratio and revised predetermined ratio to the county’s common level ratio to establish the revised common level ratio for the reassessment year. When applying the predetermined ratio change to a change in the assessment base, the assessment review board must utilize the established predetermined ratio for the

reassessment year. This continues until the common level ratio determined by the STEB reflects the revaluation of properties, when a countywide reassessment of the properties is performed.<sup>6</sup> The effect of these two statutory changes was to give standing to appellants to appeal, and to reduce the assessment standard against which a reduction is being requested. If the CLR is found to be 70 percent of a PDR of 100 percent, because the difference between the CLR and the PDR is more than 15 percent, the appeals board must utilize the 70 percent rather than 100 percent when deciding what the appealed assessment can be. Once one property wins an appeal, others follow; this creates massive uncertainty about what the property tax will bring per mil of levy for the county, and school districts and municipalities within said county. Reassessment or a change in the PDR can forestall such uncertainty.

Following the 1986 legislation, the Pennsylvania General Assembly enacted several other statutes designed to control growth and complaints about higher real estate taxes: Act 50 (1998), Act 24 (2001), Act 72 (2004), and Act 1 (2006). Act 50 of 1998 enabled school districts to levy higher earned income taxes or net profits taxes; however, the increased revenue had to be used to reduce property taxes. This was an optional tax shift aimed at reducing or eliminating some taxes in favor of others. Additionally, Act 50 enabled elected county, school district, and municipal officials to allow the provision of homestead and farmstead exclusions. Act 50 also allows eligible taxpayers to defer property tax increases.<sup>7</sup> Initially, only four school districts in Pennsylvania enacted the Act 50 shift, but over time the implementation of homestead and farmstead exclusions has grown (Bumbarger, 2010). Three years later, the General Assembly passed Act 24, the Optional Occupation Tax Elimination Act, in an attempt to increase earned income tax revenues enough to offset losses from eliminating the occupation tax.<sup>8</sup> The difference between Act 50 and Act 24 is that Act 24 does not give voters a say in future tax increases. Act 72 attempted to encourage a tax shift similar to earlier statutes.

This review suggests that there are a number of related reasons why a Pennsylvania county may choose or be forced to reassess. First, the current inequities as reflected in the coefficient of dispersion (COD) of the sales ratio<sup>9</sup> may encourage county officials to reassess. Such inequities have also been used in the courts, relying on a

constitutional non-uniformity argument, to force reassessment. Second, the perilous financial position of local governments within a county may generate support for a reassessment as a way to avoid deficits without raising millage in a visible manner. Taking this into consideration, we calculate the opening budgetary balance<sup>10</sup> as a percentage of the year's expenditures of all local governments in each county. Third, economic growth as reflected through population growth may increase the demand for public services; this will, in turn, lead to support for a reassessment in order to avoid the pain of millage increases. Fourth, reassessment may be a mechanism by which to avoid widespread appeals and the resulting tax base uncertainty. To evaluate this fourth explanation, we construct an annual "index ratio:"<sup>11</sup> the ratio of the common level ratio to the predetermined ratio. Under Act No. 1986-194, an appeal must use the predetermined ratio as the benchmark if the index ratio is more than  $.85 \times \text{CLR}$  and less than  $1.15 \times \text{CLR}$ . If the index ratio does not fall within this range, reassessment appeals might occur in order to increase the CLR and thereby forestall appeals by using this lower standard.

Because we model below the decision to reassess, and expect that a countywide reassessment will reduce inequities and the coefficient of dispersion, we inquire, following Stine (2010), how duration, or years since the last reassessment, affects the current coefficient of dispersion. An examination of the underlying CLR's and the number of taxable parcels in each county suggests that there are spatial differences in the level of assessments. To account for this we will use regional dummy variables for each metropolitan area.

## DATA AND ECONOMETRIC MODELS

### Data

Our study is based on empirical information from the property reassessments of 67 counties in Pennsylvania from 1988-2008, obtained from the Pennsylvania State Tax Equalization Board (STEB).<sup>12</sup> Eighty percent of the counties (54 out of 67) have completed at least one reassessment since 1988. The majority of such reassessments have involved comprehensive countywide reassessment instead of changing the predetermined ratio. We noted that 54 counties had at least one reassessment, 13 counties did not have any reassessments,

and 25 counties had more than two reassessments. Twenty-one counties reassessed twice, and four counties reassessed three times. Table 1 gives the frequency of reassessment, the median value of the coefficient of dispersion, and the median value of common level ratio by year from 1988-2008. Most reassessments happened after 1998: 31 reassessments occurred before 1998 and 52 reassessments after 1998. In the earlier period (1988-1998), only three counties chose to reassess more than once. In the later period (2000-2008), 19 counties chose to reassess twice and three counties chose to reassess three times.<sup>13</sup> Examining the data, we find that the COD is quite high in Pennsylvania; the mean COD is 33.44 compared to the IAAO uniformity standard of 20 or less.

Due to data availability limitations, we use 1988 as the base year and 2008 as the end year for the calculation of duration. Unfortunately, information about the characteristics of Pennsylvania assessors over time is not available so we are not able to examine these effects as reflected in equity studies in other states. If two reassessments happened continuously, the duration is defined as zero. Among 67 counties, only Montour County chose to reassess continuously in 2005 and 2006. The average duration of reassessments among 83 observations is about seven years; this is much higher than the three years typically required by those states that mandate periodic reassessments. For Pennsylvania, the average duration is 9.41 years for 29 counties with one reassessment, 5.81 years for 21 counties with two reassessments, and 5.17 years for four counties with three reassessments.

**Empirical models**

There are two endogenous variables of interest in this study: the binary decision to reassess each year and the coefficient of dispersion in sales ratios.

The latter is inherently continuous. We model the first outcome as a bivariate logit on reassessment or not, and we model the second as a specification of how various factors impact the coefficient of dispersion of the sales ratio. In the first equation, we estimate the effects of the current ratio of the CLR to PDR, historical coefficients of dispersion, legislative changes, the financial position of local governments in each county, and population growth on the decision to reassess. Because the reassessment variable is measured as the year in which reassessment takes effect, we expect the various equity and budgetary factors to work in a predetermined and lagged fashion. Based on our investigations of county-by-county graphs of the common level ratio, we note the relation between reassessments and common level ratio is instantaneous. We therefore specify that the index ratio has no delayed effect on whether reassessment occurs or not. Model 1 that explains REA<sup>14</sup> then is:

$$(1) \text{ Logit } REA_t = \alpha_1 + \alpha_2 IR_t + \alpha_3 IR_t^2 + \alpha_4 IR_t^3 + \alpha_5 COD_{t-1} + \alpha_6 COD_{t-2} + \alpha_7 A_{50} + \alpha_8 A_{24} + \alpha_9 A_{72} + \alpha_{10} A_1 + \alpha_{11} BAL_{t-1} + \alpha_{12} BAL_{t-2} + \alpha_{13} POPG_{t-1} + \alpha_{14} POPG_{t-2} + \alpha_{15} G + \sigma_t$$

Our empirical model specifies that the quality of assessment in a county depends on the effect of the passage of time since the last reassessment, the previous measures of assessment quality to capture persistence effects, the effect of a current reassessment being implemented, the various legislative dummies, and region<sup>15</sup>:

$$(2) \text{ } COD_t = \beta_1 + \beta_2 D_t + \beta_3 D_t^2 + \beta_4 D_t^3 + \beta_5 COD_{t-1} + \beta_6 COD_{t-2} + \beta_7 REA_t + \beta_8 A_{50} + \beta_9 A_{24} + \beta_{10} A_{72} + \beta_{11} A_1 + \beta_{12} G + \sigma_t$$

Table 1  
Statistics of Main Variables in Models:

	Mean	Median	Std Dev	Min	Max
Duration	6.98	6	4.67	0.00	19.00
CLR	30.92	22.40	23.64	2.80	106.70
PDR	60.98	50.00	28.75	3.70	100.00
Index Ratio	0.54	0.53	0.31	0.03	1.46
COD	33.44	33.81	10.27	3.45	74.83
BAL	0.08	0	0.21	-0.38	3.74
POPG	-0.02	0	0.15	-0.55	1.27

If the effect of period t-2 coefficients of dispersion is more significant than the effect of period t-1, we conclude that it generally takes more time for previous fairness concerns to have influences on the current equity quality of assessment. However, if the effect of period t-1 coefficients of dispersion is more significant, we conclude that it generally takes less time for previous fairness concerns to influence current equity quality. We conjecture that previous equity or quality of assessment and duration will have negative effects on current equity quality of assessment and that reassessment will lower the coefficient of dispersion. If the previous quality of assessment deteriorates and the duration of reassessment persists, we expect the equity or quality of assessment will deteriorate as well.

### EMPIRICAL RESULTS

Table 2 presents the logit results for model 1. Note that the pseudo R<sup>2</sup> gives a measure of overall fit based on the correct classification of outcomes. Overall, we properly predict 21 percent of the decisions to reassess.

The reader will note that we test and find a significant nonlinear relationship between index ratio and the decision to reassess. Generally, we expect that the pressure to reassess in order to forestall appeals is weakest when the index ratio is within the .85 to 1.15 range and that the pressure to reassess is strongest below and above this range. We thus expect a U-shaped relationship. A plot of the predicted odds of a reassessment against the index ratio confirms the U-shaped nature of this relationship. Generally, the pattern of statistically significant effects of the various explanatory variables in model 1 is as expected. A higher coefficient of dispersion, lagged one period, is associated with a greater likelihood of reassessment, and a larger opening balance among all local governments, lagged one period, is associated with a reduced likelihood of reassessment. Population growth, our surrogate measure of increased demand for public services, is not statistically related to the reassessment decision. Among the changes in state laws that govern the composition of local finance in Pennsylvania, only two of the four law changes had discernible effects on the likelihood of reassessment. The provision of homestead exclusions

Table 2  
Empirical Results of Model 1: Logit of Reassessment

<i>Explanatory Variable</i>	<i>Coefficient</i>	<i>Std. Err.</i>	<i>Z</i>
COD <sub>t-1</sub>	0.0939	0.0252	3.73
COD <sub>t-2</sub>	-0.0178	0.0260	-0.69
IR	-25.2060	4.0989	-6.15
IR <sup>2</sup>	38.8127	6.8193	5.69
IR <sup>3</sup>	-15.7320	3.2491	-4.84
Act 50	2.2038	0.3423	6.44
Act 24	-1.7769	0.3687	-4.82
Act 72	0.1092	0.4237	0.26
Act 1	-0.0723	0.8211	-0.09
BAL <sub>t-1</sub>	0.2373	0.4671	0.51
BAL <sub>t-2</sub>	-2.3365	0.7965	-2.93
POPG <sub>t-1</sub>	-0.1869	1.0673	-0.18
POPG <sub>t-2</sub>	0.0540	0.9711	0.06
Intercept	-2.1666	0.9226	-2.35

Number of Obs: 1091

Pseudo R<sup>2</sup>: 0.211

Note: regional dummies not shown

and optional shift from nuisance taxes to higher earned income taxes (Act 50) were associated with a greater probability of reassessment while the optional elimination of nuisance taxes (Act 24) was associated with a reduced probability of reassessment.

Table 3 presents the Ordinary Least Squares (OLS) estimates for model 2. Overall, the numerous explanatory variables account for 75 percent of the variation in the coefficient of dispersion across Pennsylvania's counties. A completed reassessment reduces the coefficient of dispersion by 6 percentage points. Against an average coefficient of dispersion of 33, this is an 18 percent improvement in the quality of the assessment results. Prior measures of assessment quality are positively related to the current or contemporaneous coefficient of dispersion. Surprisingly, neither of the coefficients on the lagged measures is greater than one. We modeled duration as a third order polynomial to capture any non-linearity in effects. All three coefficients are statistically significant and alter in sign. An examination of a plot between the predicted coefficient of dispersion and the duration indicates that the coefficient of dispersion drops by 3 points over the first six years and then grows through the following 11 years. The Pennsylvania General Assembly's many attempts to rationalize the composition of local finance are associated with

varying impacts on the coefficients of dispersion. Of the three statistically significant results, we note that Act 72 is associated with a 2.6 point increase in the coefficient of dispersion while Act 24 and Act 1 are associated with reductions in the coefficients of dispersion by 1 and 1.4 points, respectively. Since all four pieces of legislation were in place in 2007-2008, we see that the countervailing pressures essentially cancelled each other out.

Another way to examine the estimation results generated by the two statistical models is to calculate the elasticity effects of the various continuous right-hand side variables. Table 4 presents the effects of a 1 percent change in COD, IR, BAL, and POPG on the probability of reassessing. While all four effects are quite small, a 1 percent change in the index ratio has the largest effect (1.6 percent) on the probability of reassessing, and its impact on the decision to reassess is at least 10 times larger than that of the other explanatory variables. Table 5 reports the elasticities of the continuous explanatory variables on the coefficient of dispersion. By far the largest elasticity (albeit less than unity) is the persistence effect of the lagged coefficient of dispersion on the current coefficient of dispersion. The elasticities for the effect of duration and probability of reassessment on the coefficient of dispersion are very small.

Table 3  
Empirical Results of Model 2: OLS on COD

	<i>Coefficient</i>	<i>Standard Error</i>	<i>t</i>
REA <sub>t</sub>	-5.7682	0.5342	-10.80
COD <sub>t-1</sub>	0.5790	0.0258	22.46
COD <sub>t-2</sub>	0.1322	0.0249	5.30
D	-0.9586	0.2234	-4.29
D <sup>2</sup>	0.1213	0.0385	3.14
D <sup>3</sup>	-0.0040	0.0017	-2.39
Act 50	0.2802	0.4487	0.62
Act 24	-1.0600	0.5280	-2.01
Act 72	2.6309	0.5853	4.49
Act 1	-1.3886	0.5912	-2.35
Intercept	-5.7682	0.5342	-10.80

Number of Obs: 1391

R<sup>2</sup>: 0.746

Note: regional dummies not shown

*Table 4*  
**Effects on REA of 1% Changes in Model 1 Explanatory Variables**

<i>Percentage change in Reassessment odds</i>	
COD	0.12%
IR	1.63%
BAL	-0.10%
POPG	-5.4*10 <sup>-40</sup> %

*Table 5*  
**Effects on COD of 1% Changes in Model 2 Explanatory Variables**

<i>Percentage change of COD</i>	
COD <sub>t-1</sub>	0.5792%
D	0.0310%
REA	-0.0143%

**CONCLUSIONS**

We have sought in this paper to explain when and why Pennsylvania counties choose to reassess, as well as the impact of such reassessments on the quality of assessment results measured by the coefficient of dispersion. Generally, reassessments are a relatively rare and infrequent phenomenon in Pennsylvania. An econometric exploration of county-by-county data over the period 1988-2008 indicates that a variety of factors explain the decision to reassess. Among them, it appears that forestalling appeals is the most important consideration, followed by the financial position of municipalities and school districts within the county.

With respect to the quality of the assessment result as measured by the coefficient of dispersion in the sales ratio, we note that a reassessment on average lowers the COD by about 6 points, while the statewide average coefficient of dispersion is 33 points. Were Pennsylvania to adopt mandatory reassessment every three or four years, it is evident that the quality and fairness of the local real estate tax could be materially improved.

**Notes**

<sup>1</sup> Predetermined Ratio (PDR): “the ratio of assessed value to market value established by the board of county commissioners and uniformly applied in determining assessed value in any year.”

<sup>2</sup> 53 Pa.C.S. § 8802.

<sup>3</sup> Act No. 1986-194 amends the General County Assessment Law, and Act No. 1986-132 amends the Second Class A and Third Class County Assessment Law. Philadelphia is thereby unaffected by these two statutes.

<sup>4</sup> Common Level Ratio (CLR): “the ratio of assessed value to current market value used generally in the county as last determined by the STEB pursuant to the act of June 27, 1947 (P.L., 1046, No.447), referred to as the State Tax Equalization Board Law.” The PDR is the fraction of market value chosen to be subjected to assessment by the board of assessment.

<sup>5</sup> 72 P.S. §5020-511(c);72 P.S. §5453.702(c); 72 P.S. §5349(d.2).

<sup>6</sup> 72 P.S. § 5020-518.2.

<sup>7</sup> Real Estate Tax Deferment Program Act, 53 Pa. C.S. §§ 8571-8578 (2009).

<sup>8</sup> The occupation tax is levied in one of two ways: (1) a proportional amount based on the assessed valuation of a particular occupation, or (2) a flat rate on all working residents. 53 P.S. § 6927.2.

<sup>9</sup>  $COD=100 / Median_{A/S} * \left( \sum_{i=1}^n (A_i / S_i) - Median_{A/S} \right) / n$ , where A stands for assessed value determined by the assessor or State Tax Equalization Board, and S stands for arms-length sales price.

<sup>10</sup> Data on annual local municipal governments, school spending, and opening balances are due to the Pennsylvania Department of Economic and Community Development, personal correspondence.

<sup>11</sup> See Pennsylvania Bureau of Departmental Audit (2011) about the reliability of STEB data after 2008.

<sup>12</sup> Several missing data points were interpolated, and counties with index ratios over 2.5 were excluded from our analysis.

<sup>13</sup> The frequency of reassessment includes reassessment occurred before 2000 for the same county.

<sup>14</sup> REA = Reassessment, a dummy variable that equals one if reassessment takes effect in the year, or zero if reassessment does not take effect in the year; IR = Index ratio calculated by dividing common level ratio by predetermined ratio; CODt-1 = Coefficient of Dispersion of period t-1; CODt-2 = Coefficient of Dispersion of period t-2; A50 = Act 50, A24 = Act 24, A72 = Act 72, A1=Act 1; BALt-1= Governments opening cash balance of period t-1(%); BALt-2= Governments opening cash balance of period t-2(%); POPGt-1 = Population growth rate of period t-1(%); POPGt-2 = Population growth rate of period t-2(%); G = Vector of region dummies from 1 to 16; σ = error term.

<sup>15</sup> D = Duration, years since the last reassessment ; CODt-1= Coefficient of Dispersion of period-1; COD<sub>t-2</sub>= Coefficient of Dispersion of period t-2; A<sub>t</sub> is reassessment or not in year t; A50 = Act 50, A24 = Act 24, A72 = Act 72, A1=Act 1; G = Vector of MSA Region dummies from 1 to 15; σ = error term;

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