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厦门大学

博　士　学　位　论　文

面板数据半参数空间滞后模型的估计和应用

Estimation and Application of Panel Data Semiparametric Spatial Lag Models

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摘　要

目前，一套完整、系统的参数空间计量模型理论和方法已基本形成，并在各种学科领域中应用广泛。参数空间计量模型通常对模型形式进行预先设定，其优点在于统计推断相对简单，容易解释问题。考虑到现实经济变量间的复杂性，预先设定模型形式往往会存在较高的误设风险，估计结果也极有可能出现偏误，导致研究结果与现实问题不相符合。为了克服参数空间计量模型的局限性，我们有必要进一步对非参数\半参数空间计量模型的理论和方法展开研究，这也是本论文的研究出发点。如今，相关的研究才刚刚起步，尤其是对面板数据非参数\半参数空间计量模型的研究，基本尚处于空白。

与传统参数空间计量模型相比较，非参数空间计量模型一般具备更好的稳健性，能考察变量间的非线性特征，因此，其研究具有重要的理论意义和应用价值。然而，这类模型在研究高维数据时存在不可避免的“维数灾难”问题，这在一定程度上都限制了模型的应用范围。为了在高维数据研究中有效的规避“维数灾难”问题，并提高模型对面板数据的适用性，我们基于面板数据建立了四种新的具有降维功能的半参数空间滞后模型：固定效应面板数据空间滞后单指数模型、随机效应面板数据空间滞后单指数模型、固定效应面板数据空间滞后变系数模型以及随机效应面板数据空间滞后单指数模型。本文构建了上述模型的截面似然估计方法，并对相应估计量的大样本性质和小样本表现进行系统的研究，最后尝试将本文提出的估计技术运用于现实经济问题分析中。本文主要的研究内容和成果可概括为以下方面：

第一，面板数据空间滞后单指数模型的统计推断研究。在面板数据空间滞后线性参数模型的基础上，我们通过单指数结构的引入将解释变量与被解释变量联系起来，分别建立了两类新的固定效应空间滞后单指数模型和随机效应空间滞后单指数模型，它们既考虑了变量间的非线性性，又能有效地规避“维数灾难”问题，增强了模型的稳健性。在此基础上，构建了两类模型的截面似然估计方法；在一定的正则假设条件下，证明了其参数和非参数估计量的大样本性质；同时，我们还基于蒙特卡洛数值模拟方法考察了估计方法在小样本条件下的表现，数值

模拟结果表明所构建的估计方法在小样本情况下均有良好的表现。

第二，面板数据空间滞后变系数模型的统计推断研究。基于面板数据空间滞后线性参数模型，通过引入变系数结构，建立了两类新的固定效应空间滞后变系数模型和随机效应空间滞后变系数模型，在模型形式上允许解释变量为变系数结构，能够全面刻画解释变量中可能存在的非线性信息，增强了模型的稳健性，有效缓解“维数灾难”问题，提高了模型的适用性。在此基础上，我们构建了两类模型的截面似然估计方法，在一定的正则假设条件下证明了参数和非参数估计量的大样本性质；我们应用蒙特卡洛数值模拟方法考察了估计方法在小样本条件下的表现，结果显示所构建的估计方法具有良好的小样本表现。

第三，将理论研究成果应用于我国区域金融发展和经济增长的关系研究。基于产业结构升级的视角，我们研究了随着产业结构升级，区域金融发展和经济增长的变化关系：首先，通过引入空间区位熵指标分析了中国银行业、保险业、证券业的空间外部特征；然后，从理论上构造了一个内生增长模型，结合金融资本的技术延伸和地理流动性，推导出区域金融发展与经济增长之间的相互关系；结论说明了受到不同时期的产业结构差异性的影响，区域金融发展和经济增长的相互关系在不同经济发展阶段可能存在较大的差异。最后，我们根据理论研究成果，基于 2003-2012 年省级面板数据，建立了面板数据空间滞后变系数模型，描述金融发展与经济增长的关系，相对于面板数据参数空间滞后模型，所构建的模型能够解释随着产业结构变化，区域金融发展对经济增长的影响的非线性动态特征。结论说明区域金融发展、经济增长率以及产业结构升级之间存在典型的非线性作用机制，即在不同层次产业结构下，区域金融发展对经济增长的推动作用存在较大差异。

本文的研究方法对于其他结构的半参数空间计量模型估计理论研究具有推广价值，相应的估计技术在经济管理等社会学科中具有一定的应用价值。

关键词：空间滞后单指数模型；空间滞后变系数模型；固定效应；随机效应；截面似然估计；金融发展；经济增长

Abstract

The theory and method of the parametric spatial econometric model have been basically formed and widely used in various kinds of subjects so far. The parametric spatial econometric model is often done in the form of pre-set in research, its advantages include that the statistical inference is relatively simple and it is easy to explain the problem. Consider the complex of the economic variables in reality, there may exists a higher risk of misspecification for the model in the form of pre-set, the estimates are very likely biased and the results are not consistent with the problem. To overcome the limitation of the parametric spatial econometric model, it is necessary for us to do further study on the theory and method of nonparametric \ semiparametric spatial econometric model, which is the starting point of the thesis. The related research has just started, especially the research on panel data nonparametric \ semiparametric spatial econometric model, which is still scarce.

Compare with the parametric spatial econometric model, the nonparametric spatial econometric model has greater robustness and can study the nonlinearity between the variables, hence, it has an important significance in the theory and application. However, such models inevitably have the "curse of dimensionality" problem on high-dimensional data, so the applications of which are limited to a certain extent. Thus, in order to effectively avoid the "curse of dimensionality" problem and enhance the applicability of the model for panel data, we have constructed four new semiparametric dimension reduction spatial lag models: Fixed Effects Spatial Lag Single Index Models, Random Effects Spatial Lag Single Index Models, Fixed Effects Spatial Lag Varying Coefficient Models, Random Effects Spatial Lag Varying Coefficient Models. For these models, we have constructed their profile likelihood estimation methods and conducted a systematic study of the large sample properties and small sample performance of the estimates, and the estimation techniques have been applied to the analysis of real economic problems. The research content and results can be summarized as the following:

Firstly, the statistical inference study of panel data spatial lag single index models.

Based on the linear parametric spatial lag model, we have connected explanatory variables with explained variables via the single index structure and have established the new fixed effects spatial lag single index model and the random effects spatial lag single index model respectively, which can study the nonlinearity between the variables and can effectively alleviate the impact of the "curse of dimensionality" and enhance the robustness of the model. On this basis, we have constructed the profile likelihood estimation methods, proved large sample properties of parametric and nonparametric estimates under given regular assumption conditions. We have used Monte Carlo simulation method to show the performance of estimation method under small sample, and the results have indicated that estimation method has good performance.

Secondly, the statistical inference study of panel data spatial lag varying coefficient model. Based on the linear parametric spatial lag model, via the varying coefficient structure, we have established the new fixed effects spatial lag varying coefficient model and the random effects spatial lag varying coefficient model respectively, which allows the explanatory variables be a varying coefficient structure, These models can not only fully characterize the nonlinear relationship between the explanatory variables, but also effectively alleviate the "curse of dimensionality" problem, and improve the applicability of the models. On this basis, we have constructed the profile likelihood estimation methods, proved large sample properties of parametric and nonparametric estimates under given regular assumption conditions. We have used Monte Carlo simulation method to show the performance of estimation method under small sample, and the results have indicated that the estimation method has good performance.

Thirdly, the study of the relationship between regional financial development and economic growth based on the theoretical research results. We have studied the relationship between the regional financial development and the economic growth based on the perspective of industrial structure upgrading: we have firstly characterized the external feature of Chinese banking, insurance and securities industries via the spatial location entropy. Then, combining the technical extension

and geographical mobility of the financial capital, we have constructed a theory of endogenous growth model and deduce the relationship between financial development and economic growth. The conclusions indicate that there may exist great differences of the relationship between financial development and economic growth in different periods. Finally, according to theoretical research results, we have established the panel data spatial lag varying coefficient model based on the provincial panel data from 2003-2012 to describe the relationship between financial development and economic growth. Compare with the panel data linear parametric spatial lag model, the constructed model can explain dynamic nonlinearity between financial development and economic growth with the upgrading of the industrial structure, and the conclusion shows that there exist nonlinear interaction mechanism among regional financial development, the rate of economic growth and the levels of industrial structure, that is, there exist great differences of the effects for the economy growth from the regional financial development as the industrial structure change.

The research methods in the paper can be extended for other semiparametric spatial econometric models, and the corresponding estimation techniques also have some value in economic management and other social disciplines.

Keywords: Spatial Lag Single-Index Model；Spatial Lag Varying Coefficient Model；Fixed Effects；Random Effects；Profile Likelihood Estimation；Financial Development；Economic Growth

目 录

第 1 章 绪论 1

1.1 研究背景 1

1.1.1 非参数回归模型的重要性 1

1.1.2 空间计量模型的重要性 2

1.2 研究内容 4

1.3 研究意义 6

1.4 创新之处 8

1.5 结构安排 9

第 2 章 文献综述 11

2.1 非参数\半参数回归模型 11

2.1.1 非参数回归模型 11

2.1.2 半参数回归模型 13

2.2 空间计量模型 16

2.2.1 空间权重矩阵和空间相关性度量方法 16

2.2.2 参数空间计量模型 18

2.2.3 非参数\半参数空间计量模型 21

2.3 相关估计方法和计算方法 28

2.3.1 非参数\半参数模型的估计方法 28

2.3.2 空间计量模型的估计方法 31

2.3.3 常用的窗宽选择方法 35

2.3.4 Monte Carlo 方法和 Bootstrap 方法 38

2.4 小结 39

第 3 章 固定效应空间滞后单指数模型 40

3.1 引言 40

3.2 固定效应空间滞后单指数模型的估计 41

3.2.1 模型设定 41

3.2.2 模型估计.....42
3.2.3 估计的大样本性质.....45
3.2.4 蒙特卡罗模拟结果.....48
3.3 小结.....54
3.4 引理和定理证明.....56
第 4 章 随机效应空间滞后单指数模型.....72
4.1 引言.....72
4.2 随机效应空间滞后单指数模型的估计.....73
4.2.1 模型设定.....73
4.2.2 模型估计.....74
4.2.3 估计的大样本性质.....77
4.2.4 蒙特卡罗模拟结果.....80
4.3 小结.....86
4.4 引理和定理证明.....87
第 5 章 固定效应空间滞后变系数模型.....105
5.1 引言.....105
5.2 固定效应空间滞后变系数模型的估计.....106
5.2.1 模型设定.....106
5.2.2 模型估计.....107
5.2.3 估计的大样本性质.....110
5.2.4 蒙特卡罗模拟结果.....113
5.3 小结.....118
5.4 引理和定理证明.....119
第 6 章 随机效应空间滞后变系数模型.....131
6.1 引言.....131
6.2 随机效应空间滞后变系数模型的估计.....132
6.2.1 模型设定.....132

6.2.2 模型估计.....133
6.2.3 估计的大样本性质.....135
6.2.4 蒙特卡罗模拟结果.....138
6.3 小结.....144
6.4 引理和定理证明.....145
第 7 章 产业结构升级视角下的区域金融发展与经济增长.....157
7.1 引言.....157
7.2 相关研究评述.....158
7.3 理论分析框架.....161
7.3.1 金融发展的外部特征.....161
7.3.2 金融发展的内部机制.....163
7.3.3 金融发展的内生增长模型.....164
7.4 实证研究框架.....167
7.4.1 指标选取和数据来源.....168
7.4.2 模型设定和估计.....169
7.5 实证结果及分析.....171
7.5.1 空间相关性检验.....171
7.5.2 线性面板数据空间滞后模型研究结果.....172
7.5.3 面板数据空间滞后变系数模型研究结果.....173
7.6 小结.....176
第 8 章 研究总结与研究展望.....179
8.1 研究总结.....179
8.2 研究展望.....180
参考文献.....182
致谢.....195
攻读博士学位期间的科研成果.....197

Content

Chapter 1 Introduction..... 1

1.1 Research Background.....1

1.1.1 Importance of Nonparametric Regression Models..... 1

1.1.2 Importance of of Spatial Econometrics.....2

1.2 Research Content Research..... 4

1.3 Research Significance..... 6

1.4 Innovation.....8

1.5 Structure Arrangement..... 9

Chapter 2 Literature Review.....11

2.1 Nonparametric\Semiparametric Regression Models.....11

2.1.1 Nonparametric Regression Models..... 11

2.1.2 Semiparametric Regression Models.....13

2.2 Varying Coefficient Regression Models..... 16

2.2.1 Spatial Weight Matrix and Measurement Method of Spatial Correlation.... 16

2.2.2 Parameter Spatial Econometric Models..... 17

2.2.3 Nonparametric\Semiparametric Spatial Econometric Models.....21

2.3 Introduction of Estimation Methods and Computing Methods..... 28

2.3.1 Estimation Methods of Nonparametric\Semiparametric Models.....28

2.3.2 Estimation Methods of Spatial Econometric Models.....31

2.3.3 Bandwidth Choice.....35

2.3.4 Monte Carlo Method and Bootstrap Method..... 38

2.4 Conclusion..... 39

Chapter 3 Fixed Effects Spatial Lag Single Index Models..... 40

3.1 Introduction.....40

3.2 Estimation of Fixed Effects Spatial Lag Single Index Models.....41

3.2.1 Model Specification..... 41

3.2.2 Estimation Method..... 42
3.2.3 Large Sample Properties of Estimators..... 45
3.2.4 Monte Carlo Simulation..... 48
3.3 Conclusion..... 54
3.4 Proofs of Lemmas and Theorems..... 56
Chapter 4 Random Effects Spatial Lag Single Index Models..... 72
4.1 Introduction..... 72
4.2 Estimation of Random Effects Spatial Lag Single Index Models..... 73
4.2.1 Model Specification..... 73
4.2.2 Estimation Method..... 74
4.2.3 Large Sample Properties of Estimators..... 77
4.2.4 Monte Carlo Simulation..... 80
4.3 Conclusion..... 86
4.4 Proofs of Lemmas and Theorems..... 87
Chapter 5 Fixed Effects Spatial Lag Varying Coefficient Models... 105
5.1 Introduction..... 105
5.2 Estimation of Fixed Effects Spatial Lag Varying Coefficient Models..... 106
5.2.1 Model Specification..... 106
5.2.2 Estimation Method..... 107
5.2.3 Large Sample Properties of Estimators..... 110
5.2.4 Monte Carlo Simulation..... 113
5.3 Conclusion..... 118
5.4 Proofs of Lemmas and Theorems..... 119
Chapter 6 Random Effects Spatial Lag Varying Coefficient Models. 131
6.1 Introduction..... 131
6.2 Estimation of Random Effects Spatial Lag Varying Coefficient Models... 132
6.2.1 Model Specification..... 132

6.2.2 Estimation Method..... 133
6.2.3 Large Sample Properties of Estimators..... 135
6.2.4 Monte Carlo Simulation..... 138
6.3 Conclusion..... 144
6.4 Proofs of Lemmas and Theorems..... 145
Chapter 7 Regional Financial Development and Economic Growth Based on the Perspective of Upgrading of Industrial Structure..... 157
7.1 Introduction..... 157
7.2 Literature Review..... 158
7.3 Theoretical Framework..... 161
7.3.1 External Features of Financial Development..... 161
7.3.2 Internal Mechanism of Financial Development..... 163
7.3.3 Endogenous Growth Model of Financial Development..... 164
7.4 Empirical Structure..... 167
7.4.1 Index selection and Data Source..... 168
7.4.2 Model Specification and Model Estimation..... 169
7.5 Empirical Results and Analysis..... 171
7.5.1 Spatial Correlation Test..... 171
7.5.2 Results of Linear Panel Data Spatial Lag Models..... 172
7.5.3 Results of Panel Data Spatial Lag Varying Coefficient Models..... 173
7.6 Conclusion..... 176
Chapter 8 Research Conclusion and Prospects..... 179
8.1 Research Conclusion..... 179
8.2 Research Prospects..... 180
Reference..... 182
Acknowledgements..... 195
Scientitic Achivements during PhD Study Period..... 197

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