



THE UNIVERSITY
of ADELAIDE

**Essays on the Economic Impacts of Climate Change on
Agriculture and Adaptation**

Huang Kaixing

Submitted to the University of Adelaide in partial fulfillment of the requirement for the
degree of

Doctor of Philosophy

In

Economics

June 2016

Declaration

For a thesis that contains publications

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

I give consent to this copy of my thesis when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

The author acknowledges that copyright of published works contained within this thesis resides with the copyright holder(s) of those works.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

Signature

Date 21 June 2016

Abstract

The thesis studies the potential economic impacts of climate change on agricultural production and estimates to what extent adaptations can help to offset the potential damages of climate change on agricultural profits. The thesis consists of three journal-style articles. Chapter 1 is the introduction.

Chapter 2 is the article “Why do econometric studies disagree on the effect of warming on agricultural output? A meta-analysis”. This article conducts a meta-analysis based on 130 primary econometric studies to better understand the conflict among the existing estimates of warming on agriculture. We find that differences in the latitude of the study sample, the temperature measure that was used, the econometric approach that was applied, and publication biases can explain why the primary studies disagree. We also find that this disagreement can be reduced if the primary studies use a yearly temperature measure and adopt the hedonic modelling approach, as in doing so, they will tend to produce estimates with a similar but previously supported view that warming will lead to positive effects on agriculture in the high latitudes and negative effects in the low latitudes.

Chapter 3 is an article “How large is the potential economic benefit of agricultural adaptation to climate change? Evidence from the United States”. Based on the meta-analysis of Chapter 2, this article argues that studies of climate change impacts on agricultural profits using panel data typically do not take account of adaptations over time by farmers, and those that do tend to use the standard hedonic approach which is potentially biased. As an alternative, this chapter develops a panel framework that includes farmer adaptation. When tested with United States data, this study finds that the negative impact of expected climate change on farm profits by 2100 is only one-third as large once likely adaptation by farmers is taken into account.

Chapter 4 is the third article “The potential benefits of agricultural adaptation to warming in China in the long run”. Based on a panel of household survey data from a large sample in rural China, the article adopts the panel approach proposed in Chapter 3 to estimate the potential benefits of adaptation and to identify the determinants of farmers’ adaptation capability. The empirical results suggest that, for various model settings and climate change scenarios, long-run adaptations should mitigate one-third to one-half of the damages of warming on crop profits by the end of this century. These findings support the basic argument of the hedonic approach that omitting long-run adaptations will dramatically overestimate the potential damage of climate change. The chapter also finds that household-level capital intensity and farmland size have significant effects on farmers’ adaptive capacities.

Acknowledgements

I gratefully acknowledge the constant supervision and support from my principal supervisor, Prof. Christopher Findlay. I owe sincere thanks to my co-supervisors, Prof. Kym Anderson, Prof. Wendy Umberger, and Dr. Jacob Wong. I am hugely indebted to my co-authors, Prof. Jikun Huang, Prof. Jinxia Wang, and Dr. Nicholas Sim, for their invaluable efforts on the methodology and writing of the articles included in Chapter 2 and Chapter 4.

I am very grateful to my family and friends for their support and companionship during the past three years that I spent working on this thesis. I am forever indebted to my wife Yang Yang, for her understanding, endless love, and unconditional support.

Finally, I thank all professional staff in the School of Economics for their heartwarming help. The financial support from the School of Economics, University of Adelaide is gratefully acknowledged.

Contents

Essays on the Economic Impacts of Climate Change on Agriculture and Adaptation.....	i
Declaration.....	ii
Abstract.....	iii
Acknowledgements.....	v
Contents	vi
List of Tables	viii
List of Figures.....	ix
Chapter 1 : Introduction.....	1
1.1. The economics impacts of climate change on agriculture.....	1
1.2. The extent to which adaptations help to offset climate change impacts.....	3
1.3. The determinants of farmers’ adaptation capability	7
Statement of Authorship for Chapter 2.....	10
Chapter 2 : Why Do Econometric Studies Disagree on the Effect of Warming on Agricultural Output? A Meta-Analysis	11
2.1. Introduction.....	12
2.2. The meta-regression model.....	14
2.3. Data and the statistical analysis	16
2.4. Meta-regression results	28
2.5. Conclusion	38
2.6. Appendix: primary studies included in the meta-analysis	39
Chapter 3 : How Large is the Potential Economic Benefit of Agricultural Adaptation to Climate Change? Evidence from the United States.....	53
3.1. Introduction.....	54

3.2. Methodology and Data	61
3.3. Empirical Results.....	73
3.4. Robustness Checks	80
3.5. Concluding remarks.....	91
3.6. Appendix.....	93
Statement of Authorship for Chapter 4.....	106
Chapter 4 : The Potential Benefits of Agricultural Adaptation to Warming in China in the Long Run	107
4.1. Introduction.....	108
4.2. Data sources and summary statistics	112
4.3. Conceptual framework and econometric approach	120
4.4. Empirical results	128
4.5. Conclusions.....	136
Chapter 5 : Concluding Remarks	137
5.1. Sources of the heterogeneity in the climate change impact literature.....	138
5.2. The extent to which US agriculture will adapt to climate change	140
5.3. Determinants of farmers' adaptation capability in rural China	142
5.4. Policy recommendations.....	145
5.5. Limitation and further studies.....	146
References.....	149

List of Tables

Table 2-1: Definition of the independent variables	20
Table 2-2: Summary statistics of the independent variables	21
Table 2-3: The influence of primary study characteristics on the inconsistency of the estimated effects of warming	30
Table 2-4: The influence of primary study characteristics on the inconsistency of the estimated effects of warming (sub-group regressions)	34
Table 3-1: Climatic variations after using different fixed effects.....	64
Table 3-2 : Regression results of the effects of climatic variables on agricultural profits and farmland values.....	75
Table 3-3: Predicted end-of-this-century impact of climate change on agricultural profits and the benefits of adaptation.....	78
Table 3-4: Robustness checks for the estimated impacts of climate change and the benefits of adaptation (billions of 2012 constant dollars/year).....	86
Table 3-5: the consequences of fixed effects on the climate change impact panel study.....	94
Table 3-6: A summary of agricultural production data	100
Table 3-7: Summary Statistics of Climate Normal and Climate Predictions	100
Table 4-1: Definition of variables.....	116
Table 4-2: Summary statistics of variables.....	117
Table 4-3: Predicted changes in yearly climatic variables	119
Table 4-4: The magnitudes of inter-county climate variation and local weather shocks	123
Table 4-5: Regression results of the effects of climatic variables and household characteristics on agricultural profits.....	130
Table 4-6: Impacts of warming on crop profits by the end of this century and the benefits of long-run adaptation (2010 constant USD per hectare per year)	132

List of Figures

Figure 1-1: Value of land as a function of average temperature	4
Figure 2-1: Geographic distribution of the observations	19
Figure 2-2: Distribution of the meta-dependent variable within each latitude quintile group .	23
Figure 2-3: Temperature measures and the estimated effects of warming	25
Figure 2-4: Publication status and the estimated effects of warming	26
Figure 2-5: Incorporating adaptations and the estimated effects of warming	27
Figure 2-6: Biological differences and the estimated effects of warming	28
Figure 2-7: Distributions of the effects of warming within each latitude quintile group for hedonic studies that use yearly temperature measures	38
Figure 3-1: Predicted end-of-this-century impact of climate change on agricultural profits and farmland rents	77
Figure 3-2: Geographic distribution of county-level effects of climate change by the end of this century under scenario CCSM4 RCP4.5	90
Figure 3-3: Geographic distributions of GDD and GTP for climate normal and scenario CCSM4 RCP4.5	102
Figure 3-4: Yearly mean temperature fluctuations in the US, 1960–2010	104
Figure 3-5: A simulation of farmers’ believed “true” temperature rise after an assumed 5 °C temperature increase in the base year	105
Figure 4-1: Sample provinces of the survey in China.	113