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Resource abundance, financial crisis and economic growth: did resource-rich countries fare better during the global financial crisis?

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This study examines the role of resource abundance in the cross-country differences in the impacts of the global financial crisis (GFC) of 2008–2009. Using forecasts from the unobserved components model and exponential smoothing technique, we estimate the output levels a country would reach in 2009 and 2013 in the absence of the GFC, and compare these with the realised output levels. We find large variations in the output losses across 72 countries. The mineral-rich countries have been found to be in a strong position to survive any adverse shocks stemming from the GFC. Income per capita, trade openness, and institutional quality and government effectiveness are also found to be key factors determining the differences in output loss in the post-crisis period. These findings have strong implications for resource-rich countries such as Australia and are expected to shed new light on alternative policy designs and appropriate strategies to deal with any future economic crisis.

Key words: economic growth, energy rents, global financial crisis, mineral rents, resource abundance, unobserved components model.

1. Introduction

Some countries are blessed with abundant natural resources. Are these countries better equipped to deal with external shocks? What role, if any, does resource abundance play in the event of an economic crisis? In this study, we attempt to answer these questions in the light of the 2008–2009 global financial crisis (GFC). The impacts of the GFC were widespread, and there has been considerable debate over the role of macroeconomic policies and that of economic conditions prevailing in the affected countries prior to the crisis. Some countries were hit hard by the GFC initially but recovered very quickly, but for others, the situation went from bad to worse. As it is now more than 10 years since the GFC first hit the world economy, it is time to re-examine the impacts of the GFC. In particular, in order to avoid such a large-scale crisis in the future, we need to understand in greater detail the effect of policy responses and structural and institutional factors on the size of the recession and speed of the recovery process across countries.

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In extant literature, a wide range of factors including country-specific factors (such as domestic credit growth), external factors (such as trade and financial channels) and initial conditions have been identified as determinants of cross-country variations in the impacts of the GFC. For details, see, for example, Reinhart and Rogoff (2008), Crotty (2009), Lane and Milesi-Ferretti (2011), Berkmen *et al.* (2012), Frankel and Saravelos (2012), Dwyer and Tan (2014), and Rose and Spiegel (2011). However, none of these GFC-related studies explores the role of the resource boom, which a number of resource-rich countries including Australia enjoyed, even in the aftermath of the crisis.[1] Since the start of the 2000s, many resource-based economies have experienced rapid and substantial increases in their commodity prices.[2] In particular, the rising trend in prices has been very prominent for mining products such as iron ore, gold and silver. There were sharp declines in many mineral and fuel prices in the 2008–2009 period, but these were followed by sharp increases in the respective prices, which peaked around 2012. In general, countries rich in mineral resources such as Australia, Chile and Peru did not suffer as much as many other countries did as a result of the GFC.

Table 1 shows the growth performance of a few leading resource-rich nations during 2008–2013. In the table, we have reported growth rates of top rent earners in mineral resources, oil and gas. Chile is the world's leading copper producer, and during 2002–2007, it received 13.07 per cent of GDP (on average) from mining resources. Even though the Chilean output level declined in 2009, the economy recovered very quickly and grew at more than 5 per cent rate in the following years. The economy of Peru (rich in mineral resources such as copper, silver, iron ore and zinc) also grew at a very high rate during 2008–2013 despite the slowing down in 2009. Australia, the world's leading producer of iron ore, gold, copper and aluminium, is one of the most fortunate industrialised economies as it avoided recession during the crisis period. The oil- and gas-rich countries usually enjoy much higher resource rents as a share of GDP. Angola, Kuwait and Saudi Arabia were the top three oil-producing countries in terms of oil rents (OLR) during 2002–2007. Similarly, Qatar, Bolivia and Algeria were the three top-most gas-rich countries in the world. It is apparent that except for Kuwait, the leading oil- and gas-rich countries showed remarkable growth performance in the aftermath of the GFC.

The above statistics give us an idea about the excellent growth performance of a few resource-rich countries. However, we need to look beyond these growth statistics to find out whether abundant natural resources saved those countries, or whether their economic structure and policies helped them avoid severe consequences of the GFC. Irrespective of resource rents received, a small economy may grow at a faster rate than a big economy. Similarly, a country's capital market, macroeconomic policies and institutional quality,

[1] A resource-rich country, in this paper, is defined as a country that receives relatively high rents (as a percentage of GDP) from mineral and energy resources.

[2] Plots of the prices of a few relevant commodities are shown in Appendix S1.

Table 1 Growth performance of selected resource-rich countries

Resource-rich country	Average resource rents, 2002–2007 (% of GDP)	GDP growth (%)					
		2008	2009	2010	2011	2012	2013
Chile (mineral)	13.07	3.66	−1.04	5.76	5.85	5.56	4.89
Peru (mineral)	4.87	9.76	0.91	8.78	6.93	6.31	5.40
Australia (mineral)	3.02	2.67	1.42	2.63	2.42	3.67	2.70
Angola (oil)	56.98	13.82	2.39	3.45	3.87	6.80	5.57
Kuwait (oil)	48.63	2.48	−7.08	−2.37	6.30	5.08	0.82
Saudi Arabia (oil)	44.59	8.43	1.83	7.43	8.57	5.13	3.57
Qatar (gas)	18.24	6.15	3.36	4.13	5.17	5.18	5.40
Bolivia (gas)	17.53	2.00	1.70	3.60	2.60	2.56	3.05
Algeria (gas)	16.70	5.25	−7.82	4.50	4.29	3.44	1.49

Source: The Conference Board (2014) and The World Bank (2016a).

etc. are also expected to affect a country's growth performance in the aftermath of the crisis. An in-depth counterfactual econometric analysis is required to isolate the role of resource rents from other factors in determining the impacts of the GFC, and this is the main objective of this study.

The motivation for this study lies with the idea that a country rich in natural resources could be in a strong position to withstand external shocks from cross-border financial crisis. Such a country could pursue more aggressive fiscal and monetary policies in order to achieve macroeconomic goals compared to those countries lacking natural resources. Basic macroeconomic principles suggest that boosting aggregate expenditure is the key to avoiding a recession. A surge in resource prices usually causes a large increase in investment in relevant resource industries, and a country may benefit from these investments even after the end of the resource boom. In a recent study, Clements and Li (2017) claim that resource investment played a leading role in the strong performance of the Australian economy and helped it avoid the worst of the GFC. Garnaut (2012) also observes that resource rents have been the main stimulus to the exceptional growth in business investment in Australia during and after the GFC. Higher export receipts associated with resource rents are often distributed in the economy as increased wage payments, royalties, dividends and tax revenues, which can help increase aggregate spending and demand during the crisis period. Higher resource rents can also generate enhanced optimism in the economy, which, in turn, may lead to the booming stock market activity, and cause positive wealth effects, which enhance the level of spending.

Increased resource rents, however, may not help boost the level of spending if it makes the country's currency stronger, thereby making its other industries less competitive in domestic and international markets (the 'Dutch disease' effect).[3] There are also a number of studies that label resource abundance as a resource curse, establishing a link between natural resource

[3] For details on the different channels through which increased resource rents may affect other sectors in an economy, see Corden and Neary (1982) and Corden (1984).

abundance and slow economic growth in general (e.g. Sachs and Warner 1995, 2001; Rodríguez and Sachs 1999). Fleming *et al*. (2015) observe mostly positive effects of resources in local economies of Australia; however, negative effects in parts of the country are also reported in this study. Anderson (1998) suggests that natural resource-rich countries grow relatively slower not because of declining terms of trade and rising restrictions to primary product markets abroad; rather, such slower pace of growth could be attributed to distortionary policy choices by those countries. Mehlum *et al*. (2006) and Van der Ploeg (2011) stress that whether natural resources become a curse or a blessing depends on the quality of institutions and fidelity of the rule of law in that country. As indicated by Tornell and Lane (1999) and Lane and Tornell (1996), if increased resource rents put a large amount of resources in the hands of the state, then private agents may participate in rent-seeking activities rather than productive activities, which ultimately may hurt economic growth.

Our objective in this study is not to find the root cause of the GFC; we rather restrict our analysis to investigation of the role of resource rents, in particular, mineral and energy rents, while controlling for other economic and policy factors in the cross-country differences in the output effects of the GFC. This paper makes two main contributions to existing literature. First, we estimate the loss of GDP for the period of six years after the GFC, with output loss computed from the differences between actual GDP and forecast GDP for 72 countries. To the best of our knowledge, no other previous studies, except Berkmen *et al*. (2012), have done such a counterfactual study using a large number of countries. That study, however, depends on published forecast data to estimate the output loss for only one year after the crisis. In contrast, we made our own forecast for each of the countries in order to find out where an economy would reach six years after the crisis if there had not been any GFC. By extending the time horizon, we are able to analyse the role of policy changes and other exogenous factors that might have influenced the recovery process in these countries.

Second, we explicitly address the role of various resource rents in determining the effects of the crisis. There is a vast literature addressing the debate over resource curse/boom. Our study is not aimed at revisiting that issue; our main objective is to see whether the resource-rich countries were in a better position to tackle the adverse effects of the GFC. Again, to the best of our knowledge, no previous studies have looked into the role of resource rents in reducing the impacts of the GFC. We indeed find that mineral rents (MNR) have affected the output loss negatively, implying that resource abundance, through increased resource rents, might have helped countries rich in minerals to avoid greater output loss.

The rest of the paper is organised as follows: Section 2 discusses the estimation of output loss for each of the 72 countries. Section 3 discusses the role of resource rents and other factors in determining the differences in output loss across countries. Finally, Section 4 concludes the paper.

2. Estimating the output loss

We first attempt to estimate where a country's real GDP would have reached by 2013 if there had not been any crisis in 2008.[4] To do this, we use annual real GDP data ranging from 1960 to 2007 and forecast the real GDP figure in 2013 for each country. The difference between the forecast and actual real GDP in 2013 gives us the estimate of output loss six years after the GFC commenced. For comparison purposes, we have also estimated their GDP for 2009 using the same method.

The forecasting in this study is mainly based on the unobserved components (UC) modelling approach (see Harvey 1989). The main feature of the UC class of models is the decomposition of a time series into a trend, cycle and irregular components, with each component formulated as a stochastically evolving process over time (Koopman and Ooms 2011). The decomposition of a time series into its components not only helps us better understand the salient features of a time series but also provides a way of weighting the data in projecting the future path of a time series. We take GDP data for 72 countries and use the UC model to forecast GDP on a country-by-country basis. The real GDP data (in 1990 US$) for 72 countries have been collected from The Conference Board (2014), the Total Economy Database. The countries selected cover a wide range of developed and developing nations. Efforts have been made to include countries from all over the world. However, the selection of countries is also constrained by data availability. As our initial analysis is about forecasting GDP from past data, in our analysis we mainly include countries that have a long GDP data series. We use GDP data spanning 1960–2007 and transform them in their logarithms to estimate the UC models and forecast the 2009 and 2013 figures for all 72 countries.

As described in Harvey (1989, 2006), a UC model can be set up as:

$$Y_t = \mu_t + \psi_t + \varepsilon_t, \tag{1}$$

where Y_t is log of real GDP, and the three relevant UC are the trend (μ_t), cycle (ψ_t) and white noise irregular component (ε_t).
The trend is assumed to be smooth with a unit root and is defined as:

$$\mu_t = \mu_{t-1} + \beta_{t-1}, \tag{2}$$

$$\beta_t = \beta_{t-1} + \zeta_t. \tag{3}$$

Here, β_t is the slope component, and the trend would become a deterministic one, that is $\mu_t = \mu_0 + \beta_t$, if the variance of the slope disturbance term (ζ_t) is restricted to zero. Many empirical implementations of the UC model allow

[4] We forecast 2013 data to compare this with actual GDP figures in 2013. World prices of energy and minerals appear to have a declining trend since 2013, so there might not be any effect of resource rents after 2013.

the slope of the trend to evolve as a random walk; see, for example, Harvey (1985), Clark (1987) and Harvey and Jaeger (1993). Our approach is similar to these studies and imposes a smooth trend in the series.

The cycle component of a series can be formulated as a stationary autoregressive moving average process. An alternative to this is to model the cycle as a trigonometric process and express this as a mixture of *sine* and *cosine* waves as follows:

$$\begin{bmatrix} \psi_t \\ \psi_t^* \end{bmatrix} = \rho \begin{bmatrix} \cos\lambda_c & \sin\lambda_c \\ -\sin\lambda_c & \cos\lambda_c \end{bmatrix} \begin{bmatrix} \psi_{t-1} \\ \psi_{t-1}^* \end{bmatrix} + \begin{bmatrix} \kappa_t \\ \kappa_t^* \end{bmatrix} \quad (4)$$

where ρ is the damping factor, with $0 \leq \rho < 1$, and λ_c is the frequency of the cycle. The disturbances $\varepsilon_t, \zeta_t, \kappa_t$ *and* κ_t^* are serially and mutually uncorrelated. Harvey (2006) has shown that the UC forecasting model can also be given an autoregressive integrated moving average (ARIMA) or error correction representation. ARIMA models are indeed a viable option for forecasting; however, they can only be applied to a stationary series. Given that the aggregate output levels are mostly nonstationary, the UC model has an added advantage here, since unlike ARIMA models, the UC method can be applied directly to a nonstationary variable. Another advantage of the UC model over other univariate time-series models is that additional explanatory variables can be included in Equation (1) and structural breaks can be incorporated in any of the components.

The model is estimated using a maximum-likelihood method in which the Kalman filter is used to compute the likelihood function.[5] The model is set in a state-space form and implemented in the STAMP package of Koopman *et al.* (2000). Once the model parameters are estimated, it is relatively straightforward to generate the multi-step forecasts and relevant standard errors for the series and their components. Our main objective is to forecast real GDP for the year 2013 and then compute the output loss by subtracting the actual 2013 GDP figure from the forecast figure on a country-by-country basis.

An alternative reliable option for forecasting is the exponential smoothing technique. Forecasting procedures based on exponential smoothing, which puts more weights on the most recent data in forecasting future observations, are quite popular for its simplicity and effectiveness. As a robustness check of our forecasting, we have thus considered the exponential smoothing technique along with the UC model.

To demonstrate some examples of what we did, in Figure 1 we report forecast GDP values (in logs) for 2008–2013 along with original data (in logs) ranging from 1998 to 2007 for four countries—the United States of America (USA), Australia, Greece and India. The forecasts from the exponential smoothing model are not much different from those obtained from the UC

[5] See Durbin and Koopman (2012) for details.

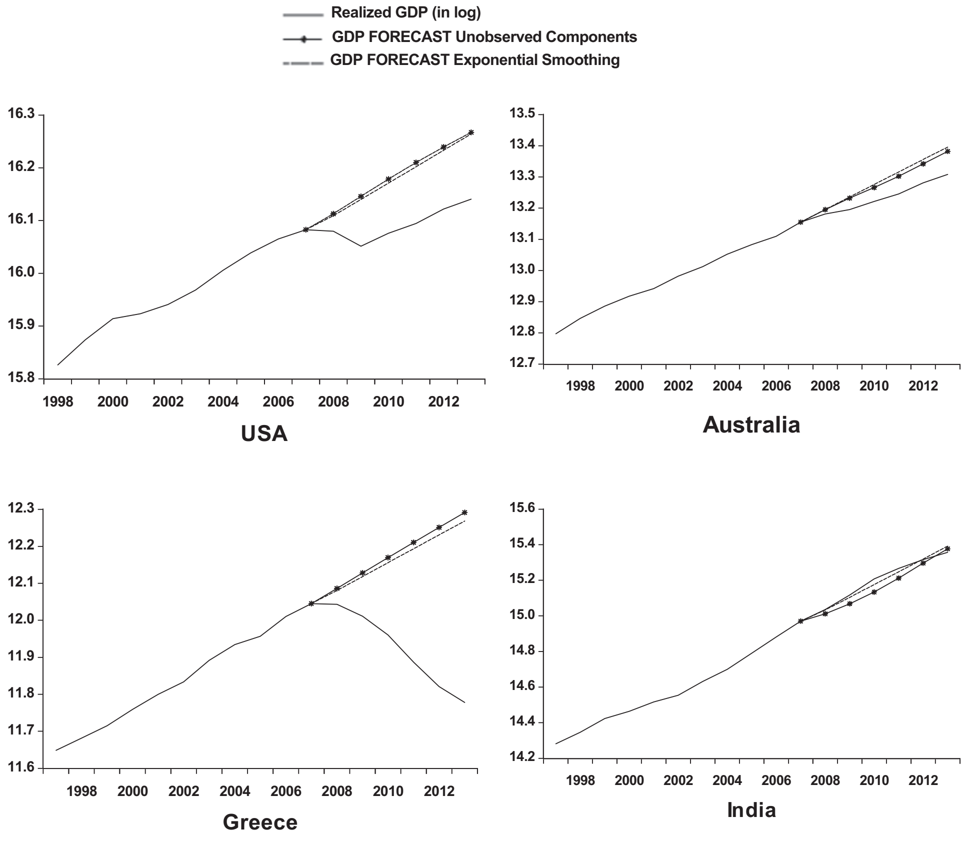

Figure 1 Real GDP (actual and forecast) for the USA, Australia, Greece and India.
Note: The forecasts are based on the estimation that uses data from 1960 to 2007.

model. It can be observed that the US economy started to recover in 2010, but by 2013, the output level was still much lower than it would have been in the absence of the GFC.

Australian GDP growth has slowed since 2008, but it has not experienced negative growth as a result of the GFC. The actual output level in Australia is lower than the forecast one in 2013. However, the gap between the forecast and actual data is much narrower than in the case of the USA. The situation of Greece is interesting. Up until 2007, the Greek economy was doing well, but from 2008, it has been heading in the opposite direction, and there is no sign of recovery at all. The gap between the forecast and actual data has widened over time. For India, the economy was actually doing better than the projected path initially; however, in later years, the realised GDP has gone slightly below its forecast.

It is beyond the scope of this study to show such plots for each country. However, in Table 2, we report the differences between the forecast from the UC model and actual GDP (the output loss) in 2009 and 2013 for all 72 countries. There is a large variation in the lost output across countries, and

Table 2 Estimation of output loss – unobserved components method

Country	Output loss		Country	Output loss		Country	Output loss	
	2009	2013		2009	2013		2009	2013
Algeria	0.0700	0.1139	Guatemala	0.0704	0.1633	Philippines	0.0614	0.0509
Angola	0.0803	0.4334	Hong Kong	0.0711	0.0979	Poland	0.0534	0.1174
Argentina	0.1342	0.2925	Hungary	0.0997	0.1821	Portugal	0.0792	0.1898
Australia	0.0366	0.0738	Iceland	0.1389	0.3072	Qatar	−0.0050	0.2071
Austria	0.0919	0.1710	India	−0.0498	0.0198	Romania	0.1105	0.3377
Bahrain	0.0403	0.1655	Indonesia	0.0382	0.0510	Russia	0.1857	0.4400
Bangladesh	−0.0179	−0.0313	Iran	0.0950	0.3224	Saudi Arabia	0.0049	−0.0331
Belgium	0.0572	0.0706	Ireland	0.1945	0.3638	Singapore	0.1417	0.1469
Bolivia	−0.0025	−0.0171	Israel	0.0237	−0.0028	South Africa	0.0652	0.1413
Brazil	0.0428	0.1092	Italy	0.0953	0.1622	Spain	0.1056	0.3093
Bulgaria	0.1105	0.3224	Japan	0.1164	0.1263	Sri Lanka	0.0489	0.0453
Canada	0.0851	0.1292	Kenya	0.0873	0.1491	Sudan	0.0287	0.2364
Chile	0.0439	−0.0460	Korea	0.0547	0.1608	Sweden	0.1279	0.1513
China	0.0663	0.2367	Kuwait	0.1723	0.4457	Switzerland	0.0521	0.0705
Colombia	0.0919	0.2283	Malaysia	0.0846	0.0982	Tanzania	0.0442	0.0503
Cyprus	0.0531	0.2997	Mexico	0.1117	0.0889	Thailand	0.0951	0.1217
Denmark	0.1057	0.1555	Morocco	−0.0014	0.0048	Tunisia	0.0183	0.1371
Ecuador	0.0337	−0.0069	Netherlands	0.0741	0.1553	Turkey	0.1203	0.0322
Egypt	−0.0070	0.1171	New Zealand	0.0708	0.1373	Uganda	−0.0092	0.0812
Finland	0.1817	0.2871	Nigeria	0.0670	0.1339	UAE	0.1488	0.2263
France	0.0785	0.1209	Norway	0.0782	0.1235	UK	0.1289	0.2163
Germany	0.0691	0.0475	Oman	−0.0852	−0.1706	USA	0.0944	0.1264
Ghana	−0.0207	−0.1677	Pakistan	0.0851	0.2071	Venezuela	0.1860	0.5188
Greece	0.1170	0.5137	Peru	−0.0221	−0.1086	Vietnam	0.0304	0.0797

Note: Output loss refers to the difference between forecast real log GDP and realised real log GDP in both 2009 and 2013. UAE = United Arab Emirates; UK = United Kingdom; USA = United States of America.

the gaps between forecast GDP and actual GDP have become wider over time. The 2013 estimates of the output loss range from –0.17 to 0.51 with a mean value of 0.15 and a standard deviation of 0.16. The mean and standard deviation of output loss in 2009 were 0.07 and 0.06, respectively.[6]

Some figures are worth noting here. The USA suffered a loss of more than 12 per cent relative to the projected GDP six years after the GFC occurred. In other words, if there had been no GFC, the USA would have enjoyed a GDP approximately 12 per cent higher than it did in 2013. Other high-income countries, such as the UK, Canada, France and Italy, along with most European countries have also suffered a significant loss in output. Among these 72 countries, Greece and Venezuela suffered the biggest loss (51 per cent), and Germany and Turkey are among a few fortunate European countries that escaped severe damage to their economies. It is also striking to find that some resource-abundant countries, such as Peru, Australia, Chile and Bolivia, did manage their economy well during the crisis.

As a robustness check, we have also estimated the output loss in 2013 and 2009 using the exponential smoothing method. In the exponential smoothing method, weights get reduced exponentially for older observations. With recent data getting more importance than past data, this method can be considered a very good alternative to the UC method. The output loss estimates of this method are reported in Appendix S2. While qualitatively the estimates for most of the countries are similar to those reported in Table 2, estimates for a few countries such as Angola, Argentina and Venezuela appear to be quite different.

3. Factors determining output loss

3.1 Model

The extent to which a country has been affected by the GFC may be attributed to various factors, including the initial condition of the economy and policy changes during those six years (2008–2013). However, our main focus is the role of resource rents in fighting economic downturns during the GFC and we hypothesise that various resource rents influenced the economies positively to diminish the adverse effects of the GFC.

The basic model to test our hypothesis may be specified as:

$$\mathrm{YL}_i = \alpha + \sum_k \gamma_k R_{ik} + \sum_j \delta_j X_{ij} + v_i, \qquad (5)$$

where YL denotes the output loss, which is computed for each of the 72 countries in the first stage (Section 2) of our analysis; R represents various

[6] As the GDP series are in log forms, output losses reported here can be interpreted in percentages. For instance, a mean output loss of 0.07 implies an output loss of about 7%, on average.

resource rents (expressed as a percentage of GDP); and X represents other control variables. The symbols γ and δ are relevant slope coefficients, whereas α is the constant term. The error term v_i, has the usual properties of a residual, with zero mean and constant variance. We have initially considered four resource rents, namely average OLR, natural gas rents (NGR), coal rents (CLR) and MNR.

In selecting the control variables, we closely follow previous studies such as Claessens *et al.* (2010), Lane and Milesi-Ferretti (2011), Rose and Spiegel (2011), and Berkmen *et al.* (2012). Despite the use of a wide range of macroeconomic variables by these studies, only a few common factors are often claimed to have the significant role in determining the impact of the crisis. These factors include variables representing size of an economy, degrees of financial and trade openness, pre-crisis current account deficit, public debt and credit growth. For example, Rose and Spiegel (2011) observe that countries with higher income suffered worse crises, while countries with current account surpluses (CUSs) were better insulated from slowdowns. Berkmen *et al.* (2012) find that trade channel was important for the developing countries with more open countries suffering more severely. Lane and Milesi-Ferretti (2011) report similar results in relation to the role of initial per capita income, trade openness and current account balance in the impact of the crisis. They also examine the role of financial openness, since greater degrees of financial openness may make an economy more vulnerable to the crisis through the transmission of asset price shocks across borders. They, however, do not find any evidence of adverse effect of financial openness on the crisis-period growth. In this paper, our basic model uses income per capita, trade openness, financial openness and CUS in the pre-crisis period, and average government spending (as a per cent of GDP) and changes in money supply in the post-crisis period.

Our main objective is to examine the slope coefficients of various resource rents. A significant negative γ means a positive role of the relevant resource rent variable in reducing adverse impacts of the crisis; that is, the higher the rent, the less will be the output loss. As suggested by the studies mentioned above, we would expect a positive coefficient for per capita income and trade openness and a negative coefficient for the CUS. The coefficient of financial openness is expected to be positive. However, as suggested by Lane and Milesi-Ferretti (2011), this coefficient may also have a negative sign as increased financial integration may enable domestic expenditure to be smoothed through international borrowing and lending in the event of an adverse economic shock.

Higher government spending and money supply growth might help the economies through their expansionary effects, and so we expect a negative coefficient for each of these policy variables. It is often argued that resource abundance may become a resource curse if institutional quality is poor in a country (e.g. see Sachs and Warner 1995, 2001; Mehlum *et al.* 2006; Van der Ploeg 2011). We have thus included a control variable representing institutional quality and the effectiveness of government, and we expect a negative coefficient for this variable. As a robustness check, we have also experimented with additional control variables, such as public debt, gross savings and total credit (TC).

3.2 Data

Data for our econometric analysis come from various sources. As mentioned in Section 2, for the first-stage estimation, the real GDP data (in 1990 US$) for 72 countries have been collected from The Conference Board (2014) database. For the second-stage regression analysis (Equation 5), we have considered four types of resource rents: OLR, NGR, CLR and MNR.[7] Each resource rent is defined as the difference between the value of production for a stock of relevant resources at world prices and the total cost of stock production, expressed as a percentage of GDP. Data for GDP per capita (YPC) are in 2005 US$ and have been transformed into natural logarithms. The money supply growth (ΔM2) is used as a proxy for the changes in monetary policy, whereas government consumption as a percentage of GDP (GC) is used to represent the fiscal policy stances during the periods after the crisis began. Current account surplus, gross domestic savings (GDS) and TC are expressed as a percentage of GDP. Data for all rent variables and YPC, ΔM2, GC, CUS, GDS and TC are taken from the World Development Indicator (WDI) database of the World Bank (2016a).

Data for trade openness index (TO) for all countries are taken from the Penn World table 7.1 database (Heston *et al.* 2012), and this variable is transformed into natural logarithm. For the financial openness index (FO), data are taken from Chinn and Ito (2006). Higher values of this index show relatively higher degrees of financial openness. Data for public debt as a percentage of GDP are sourced from the International Monetary Fund (IMF). Details of the source and methodology for these debt data are also explained in Abbas *et al.* (2010). Government effectiveness (GE) data are used as a proxy for institutional quality. The data are taken from the Worldwide Governance Indicator database of the World Bank (2016b). Government effectiveness is defined as the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Descriptive statistics for selected explanatory variables are reported in Appendix S3.

[7] Minerals included in the calculation of mineral rents are tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite and phosphate. Coal rents include rents from both hard coal and soft coal, and oil rents mainly include the rents from crude oil.

3.3 Estimation results

After estimating all the output loss values in a particular year in Section 2, we use the output loss for 2013 as a dependent variable in our second-stage cross-section regression (Equation 5) in this section. We initially experimented with five alternative specifications, and the results are reported in Table 3. In the first specification, we use four resource rents, namely MNR, OLR, NGR and CLR (all are as a percentage of GDP) along with a few control variables. In the second specification, we added an interaction variable to capture the effect of interaction between OLR and GE on the output loss. The first two models are estimated using the standard ordinary least squares (OLS) method. As we consider the average rents over the period of 2008–2013, there is a possibility that these resource rents have been affected by economic conditions in relevant countries leading to an endogeneity problem. To overcome this potential problem, we estimated the model using the two-stage least squares (2SLS) method (Specifications 3, 4 and 5 in Table 3). In Specification 4, instead of using oil, natural gas and CLR separately, we combine them to form a single variable (energy rents). In Specification 5, in an attempt to capture the policy effects, we added two more variables, average government consumption as a per cent of GDP and average money supply (M2) growth over the period 2008–2013.

We use relevant past rents (average of 2002–2007) as an instrument for each resource rent variable in the 2SLS estimations. Similarly, past values are used as an instrument for the two policy variables. We perform tests for instruments, and the null of weak instruments is rejected for the instruments used (not reported here). We have also estimated these models using generalised method of moments (GMM), but we have not reported the GMM results as they are similar to those obtained from the 2SLS estimates.

The per capita income is found to be a significant determinant of the output loss in all models. In general, rich countries were affected more adversely than poor countries by the GFC. This finding is consistent with previous studies such as Lane and Milesi-Ferretti (2011) and Rose and Spiegel (2011). The trade openness coefficient has the expected positive sign and appears to be significant at the 10 per cent level except in Specification 5. This implies that countries having greater trade transactions with other countries suffered more than the countries with limited trades. Financial openness coefficient is insignificant, providing no support for the popular idea that increased financial integration contributed to the global spread of the crisis (e.g. see Claessens *et al.* 2010). Our finding, however, is consistent with that of Lane and Milesi-Ferretti (2011) who show that financial openness is not associated with a low growth rate during the crisis. It is indeed quite possible that some emerging economies with no restrictions on capital flows might have enjoyed the benefit of capital inflows due to higher interest rates prevailing in these economies. It can be conjectured that countries having weak economic and legal institutions, lack of transparency and poor

Table 3 Determinants of the 2013 output loss

Explanatory variables	Dependent variable: 2013 output loss (UC model)				
	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS	(5) 2SLS
Constant	−0.6923*** (0.2441)	−0.6553** (0.2280)	−0.6741*** (0.2351)	−0.6539*** (0.2315)	−0.2860 (0.3355)
Average mineral rents, 08–13	−0.0134** (0.0065)	−0.0135** (0.0059)	−0.0110** (0.0048)	−0.0097** (0.0041)	−0.0093** (0.0040)
Average oil rents, 08–13	0.00001 (0.0036)	−0.0003 (0.0034)	−0.0001 (0.0034)	...	...
Average natural gas rents, 08–13	−0.0070 (0.0056)	−0.0019 (0.0071)	0.0016 (0.0090)	...	...
Average coal rents, 08–13	0.0119 (0.0204)	0.0197 (0.0210)	0.0325 (0.0278)	...	...
Average energy rents, 08–13	...	...	...	0.0004 (0.0029)	0.0030 (0.0041)
Initial income per capita	0.0930*** (0.0292)	0.0860*** (0.0265)	0.0849*** (0.0273)	0.0850*** (0.0279)	0.0756** (0.0330)
Initial trade openness	0.0375* (0.0209)	0.0336* (0.0206)	0.0347* (0.0210)	0.0352* (0.0198)	0.0238 (0.0234)
Initial financial openness	−0.0946 (0.0662)	−0.0677 (0.0633)	−0.0562 (0.0628)	−0.0851 (0.0587)	−0.1399 (0.0981)
Initial current account surplus	−0.0025 (0.0023)	−0.0031* (0.0022)	−0.0035 (0.0025)	−0.0039 (0.0025)	−0.0055* (0.0029)
Initial government effectiveness	−0.1183** (0.0494)	−0.0929** (0.0438)	−0.0851* (0.0467)	−0.0803* (0.0474)	−0.0594 (−0.0594)
Government effectiveness × Oil rent	...	−0.0038** (0.0022)	−0.0047** (0.0023)	...	...
Government effectiveness × Energy rent	...	...	...	−0.0039*** (0.0013)	−0.0060*** (0.0029)
Average government consumption, 08–13	...	...	...	...	−0.0074 (0.0059)
Average M2 growth, 08–13	...	...	...	...	−0.0095 (0.0092)
Adj R^2	0.289	0.323	0.314	0.332	0.128

Note: *, ** and *** represent statistical significance at the 10%, 5% and 1% level, respectively. Figures in parentheses are relevant robust (White heteroscedasticity) standard errors. All rent variables and current account surplus and government consumption are expressed as a percentage of GDP. Energy rents are the sum of oil, natural gas and coal rents. All rent variables and policy variables are the average values over the periods 2008–2013. The rest of the variables for each country use values for the initial year of 2007.

governance are more vulnerable to the crisis. This is reflected in the negative sign of the GE coefficient. This variable is strongly significant in all but the last model. Lane and Milesi-Ferretti (2011) argue that dramatic change in the perception of risk would have hit countries with large current account deficits. In all the models we used, the coefficient of current account balance has the expected negative sign; however, the evidence of the adverse role of current account deficits has not been very strong.

Irrespective of the specification we used, the MNR coefficient has a negative sign and is statistically significant at the 5 per cent level. It implies that mining rents helped reduce the output loss in mineral-rich countries in the post-crisis period. Oil rents, CLR and NGR are not found to have any significant influence on the impacts of the GFC. Many countries rich in oil resources (especially, in the Middle East, Africa and Latin America) are also the countries with governments lacking accountability, transparency and overall the democratic institutions. We thus include an interaction variable to capture the combined effect of OLR and GE in the second model. While the relevant coefficient of OLR is still insignificant, it is evident from the significance of the interaction variable that the effects of OLR in reducing the adverse effects of the GFC were dependent on the institutional quality of the country.

A number of robustness checks have been completed to confirm the results reported in Table 3. In particular, we have considered Specification 4 above and applied a few changes over this model. In Table 4, we have reported the estimated coefficients of MNR, energy rents and the interaction variables with all these changes made each time. Here, we consider the inclusion of government consumption, public debt, TC and GDS in alternative models. None of these alternative additional explanatory variables is actually significant (not shown here), and we observe that the significance of the MNR variable remains undisturbed when we added these explanatory variables to Specification 4. The energy variable is insignificant, but the interaction variable with GE remains statistically significant as before. We also re-estimate the model (Specification 4) using output loss forecast for 2013 obtained from the exponential smoothing as a dependent variable. The interaction variable is marginally insignificant, but the MNR coefficient is still significant at the 5 per cent level.

As shown in Section 2, the magnitudes of a few countries' output loss are extremely large, and these possible outliers may have affected our estimation results. As a robustness check of our main findings, we have removed potential outliers: Angola, Greece, Kuwait, Russia and Venezuela from our sample. As reported in Table 2, these five countries have the output loss values of 0.43, 0.51, 0.45, 0.44 and 0.52, respectively. Coincidentally, four of these five countries also earned a large amount of profits from the exports of oil during the crisis periods and perhaps this has contributed to the insignificance of the OLR and energy rents coefficients (Table 3). The MNR coefficient shows even stronger significance than before when these countries

Table 4 Effects of resource rents on the output loss in 2013 – *robustness checks*

	Estimated coefficient for			Adj R^2
	Mineral rents	Energy rents	Energy rents × Government effectiveness	
Initial government consumption added to Specification 4	−0.0104*** (0.0041)	0.0005 (0.0028)	−0.0042*** (0.0015)	0.223
Initial public debt added to Specification 4	−0.0112** (0.0047)	−0.0002 (0.0031)	−0.0039*** (0.0013)	0.329
Initial total credit added to Specification 4	−0.0091** (0.0042)	0.0003 (0.0029)	−0.0035** (0.0014)	0.331
Initial gross domestic savings added to Specification 4	−0.0102** (0.0044)	0.0001 (0.0030)	−0.0039** (0.0014)	0.324
Specification 4 with output loss from exponential smoothing	−0.0116*** (0.0032)	0.0013 (0.0017)	−0.0013 (0.0010)	0.406
Specification 4 with reduced samples	−0.0119*** (0.0036)	0.0001 (0.9993)	−0.0027 (0.0019)	0.260

Note: *, ** and *** represent statistical significance at the 10%, 5% and 1% level, respectively. Figures in parentheses are relevant robust (White heteroscedasticity) standard errors. Government consumption, total credit, public debt and gross domestic savings are expressed as a percentage of GDP. The pre-crisis year of 2007 is used for initial control variables.

are removed from the sample. The interaction variable is not significant anymore, suggesting that the evidence regarding the role of energy rents and its interaction with the quality of governance in affecting the magnitude of crisis is sensitive to the sample selected.

In order to understand the impact of resource abundance on the initial impacts of the GFC, we have also used the output loss in 2009 (instead of 2013) as the dependent variable. The estimation results for 2009 output loss (derived by both UC model and exponential smoothing technique) are reported in Table 5. The results indicate that both MNR and energy rents played a significant role in reducing the adverse impacts of the GFC in 2009. Financial openness and GE have also been found to help the economies in 2009. As in the case of 2013 output loss, richer countries suffered more (in terms of reduced GDP) than the poorer countries in 2009.

Overall, we have found overwhelming evidence that mineral-rich countries have been in a better position in dealing with the adverse impacts of the GFC. Even though the share of MNR is not that huge in most of the mineral-rich countries, it may help boost expenditure through increased wage payments, royalties, dividends and tax revenues, and by creating a sense of optimism in

Table 5 Determinants of the 2009 output loss

	Dependent variable: 2009 output loss	
	Output loss (UC model)	Output loss (exponential smoothing)
Constant	−0.2078*** (0.0814)	−0.2174*** (0.0655)
Mineral rents in 2008	−0.0052** (0.0026)	−0.0047** (0.0020)
Energy rents in 2008	−0.0019*** (0.0007)	−0.0015*** (0.0005)
Initial income per capita	0.0390*** (0.0081)	0.0349*** (0.0077)
Initial trade openness	0.0045 (0.0108)	0.0092 (0.0083)
Initial financial openness	−0.0421** (0.0176)	−0.0327* (0.0173)
Initial current account balance	0.0011 (0.0008)	0.0007 (0.0008)
Initial government effectiveness	−0.0346** (0.0144)	−0.0230* (0.0126)
Government effectiveness × Energy rent	−0.0008* (0.0005)	−0.0003 (0.0004)
Initial public debt	−0.0003* (0.0002)	−0.0003* (0.0002)
Adj R^2	0.347	0.406

Note: *, ** and *** represent statistical significance at the 10%, 5% and 1% level, respectively. Figures in parentheses are relevant robust (White heteroscedasticity) standard errors. Government consumption, total credit, public debt and current account balance are expressed as a percentage of GDP. The pre-crisis year of 2007 is used for initial control variables.

the economy. Another possibility is that these resource sectors may be linked to other large sectors and affect the larger sectors positively (e.g. iron ore production may boost the manufacturing sector).[8]

However, the evidence is somewhat weak for countries rich in energy. This is puzzling as oil- and gas-producing countries enjoy quite high rents (as per cent of GDP) compared to mineral-rich countries. The source of this puzzle may lie in the institutional quality of many of the oil- and gas-rich countries. Our results hinted at the possibility that whether or not resource abundance helped the energy-rich countries during the crisis period might depend on these countries' institutional quality. It may be noted that many of the energy-rich countries are Gulf countries, and in many cases, external sources (e.g. energy rents) are the main source of their governments' revenue. As Humphreys *et al.* (2007) suggest, countries that are able to generate revenue from the sale of oil and gas are less reliant on their citizens and this can lead to weak linkages between governments and citizens. Thus, the usual channels through which resource rents lead to higher levels of private expenditure and economic activity become weaker in these energy-rich countries. It is likely this is one of the main reasons why we find weak evidence of the role of energy rents in affecting the output level positively in the aftermath of the GFC. That issue warrants further research.

[8] Bashar (2015) shows that cyclical output in Australia's mining sector positively affects the transport sector's output gap and cyclical investment in the mining sector positively affects investment in the manufacturing sector.

4. Summary and conclusion

This study investigates the role of resource abundance in the cross-country differences in the impacts of the GFC and, in particular, the effects of various resource rents on the impacts of the GFC. Using pre-crisis data for 72 countries and applying the UC modelling approach and exponential smoothing method in the first stage, we estimated the output loss for these countries for the first (2009) and sixth year (2013) after the crisis started. We find a wide variation in the magnitudes of output loss in these countries, and our results in the second stage indicate that a number of factors – including pre-crisis economic conditions such as income per capita, trade openness and institutional quality – might have caused these variations. The high-income countries are found to have been more susceptible to the crisis than the low-income countries. Countries with better GE and with better institutions suffered less output loss compared to those with poor institutional quality. There is somewhat weak evidence for the negative role of trade openness in reducing the adverse impacts of the GFC.

There is a general perception that resource abundance can ensure a nation's economic prosperity. However, many previous studies conclude that natural resources are more often a curse than a blessing for a country's economic growth (see, e.g., Sachs and Warner 1995, 2001; Frankel 2010; Van der Ploeg 2011). In our study, we show that resource-rich countries – in particular, mining-based economies – benefited from MNR during the GFC. This perhaps explains why the mineral-rich economies, such as Peru, Bolivia, Chile and Australia, were so resilient to the adverse effects of the GFC. There is also some evidence that energy rents had some positive roles in reducing the adverse effects of the GFC in 2009. Energy rents appear to have helped countries with better institutional quality in later years.

Our findings are expected to contribute to the existing literature and improve our understanding of the relation between the incidence of financial crisis and the pre-crisis economic conditions, including in the presence of abundant natural resources. Rose and Spiegel (2011) argue that pre-crisis macroeconomic and financial indicators have very poor explanatory power in assessing economic performance of countries during the crisis period. To reinforce their claim, they refer to the puzzling example of Australia, Canada and South Africa, which have managed the crisis well despite having similar conditions to other advanced countries. Our findings shed light on a missing link that helps explain this puzzle by highlighting the role of mineral resources in explaining the incidence of the crisis in these countries. Minerals and metals are essential components for many modern-day consumer and capital goods including mobile phones, computers, car engines and all transport products. An interesting avenue of future research would be to identify the exact channels through which mineral resource abundance help cushion the impacts of a financial crisis.

The findings of this paper have important implications for the management of the Australian economy. It can be conjectured from our results that the increased resource rents due to the mining boom had a significant role in avoiding recession in Australia (and other mineral-rich countries) during the GFC. Australia's growing trade relationship with Asia, and in particular China, has helped the Australian mining sector thrive since the beginning of the 2000s. However, that mining investment boom in Australia came to an end around 2012/13. The slowing of the Chinese economy and falling commodity prices may persist for some time, and this will hurt the Australian mining sector further in the future. With the rise of protectionism in international trade (e.g. the trade tussles between the USA and China), experts are now predicting another large-scale global economic crisis within a few years. Unlike 2008–09, when the Australian economy was supported by the mining sector boom, the country will confront any future crisis in a different economic environment. With the end of the resource boom from mining, the Australian economy may not remain immune to a future crisis in the way it did in the past. As such, policymakers need to be prepared with alternative policy measures if such an economic crisis occurs in the future.

Data availability statement

Data are available on request from the authors.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Movements in selected commodity prices, 1996–2013.
Appendix S2 Estimation of output loss-exponential smoothing method.
Appendix S3 Descriptive statistics of the selected explanatory variables.