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DISTRIBUTIONAL CONSEQUENCES OF COMMODITY PRICE SHOCKS: AUSTRALIA OVER A CENTURY

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This paper studies the distributional impact of commodity price shocks over the short and the very long run. Using a GARCH model, we find that Australia experienced more volatility than many commodity exporting developing countries over the periods 1865–1940 and 1960–2008. We conduct cointegration tests to assess the commodity price shock inequality nexus. A single equation error correction model suggests that commodity price shocks increase the income share of the top 1, 0.05, and 0.01 percent in the short run. The very top end of the income distribution benefits from commodity booms disproportionately more than the rest of the society. The short run effect is mainly driven by wool and mining and not agricultural commodities. A sustained increase in the price of renewables (wool) reduces inequality whereas the same for non-renewable resources (minerals) increases inequality. We expect that the initial distribution of land and mineral resources explains the asymmetric result.

JEL Codes: F14, F43, N17, O13

Keywords: commodity exporters, commodity price shocks, inequality, top incomes

1. INTRODUCTION

Commodity price shocks have powerful but unequal effects on labor, capital, and land. A large literature, often referred to as the "Dutch Disease" literature, documents the effects of commodity booms on factors of production (Gregory, 1976; Corden and Neary, 1982). An increase in global commodity demand and a subsequent rise in commodity prices trigger a sharp rise in commodity exports. Typically, this causes an appreciation in the exporter's real exchange rate which in turn harms competitiveness of other tradable sectors, like agriculture and manufacturing. As a result, employment in agriculture and manufacturing might decline following a resource boom.

Even though the mechanisms through which resource booms affect employment in a resource rich economy are well understood, surprisingly little is known

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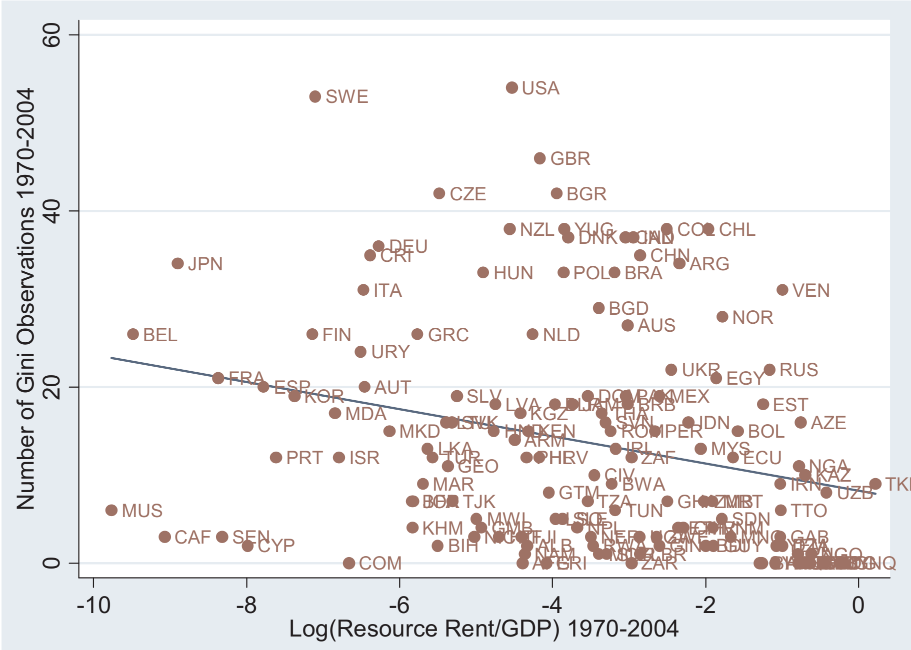

Figure 1. Resource Wealth and Missing Inequality Data

about their distributional impact. On the theory front, the distributional impact of a commodity price shock should be modest if resources are mobile. However, if there are constraints on intersectoral factor mobility, then the distributional consequences of a price shock might be significant. Furthermore, political economy theorists assert that natural resources could have a significant impact on distribution through an institution channel (Engerman and Sokoloff, 1997, 2012; Acemoglu *et al.*, 2005; Acemoglu and Robinson, 2006, 2012). They argue that natural resources influence the initial distribution of wealth and income, and thus of economic power. The distribution of economic power determines, in turn, the shape of future institutions and policies. Income and wealth inequality might, therefore, persist over the very long run. The nature and magnitude of the impact of natural resources on income and wealth distribution is, however, dependent on the type of natural resources, their initial ownership, and other initial conditions.

The theoretical ambiguity associated with the impact of resource booms on income distribution makes this an ideal empirical question. Yet, the empirical literature on this topic is surprisingly thin. One obvious reason for this is the paucity of time series data on inequality in resource rich economies. A simple plot of the number of Gini observations per country and resource rent to GDP ratio in Figure 1 illustrates the research challenge. The higher the value of log resource rent to GDP ratio on the horizontal axis, the more resource rich is a country. A negative correlation is apparent here: resource rich countries have less inequality data.

This paper addresses this gap in the literature by investigating the effects of Australian resource booms on income distribution over a century (1921–2008). In doing so, we are able to bypass the common limitations of omitted variable bias and the lack of internal validity associated with cross-national studies. Why choose Australia over other resource rich countries? First, Australia exports minerals, pastoral products, and foodstuffs. Therefore, its history allows us to track any potential heterogeneous effects across commodities. Second, Australia offers high quality time series data on both commodity prices (Bhattacharyya and Williamson, 2011) and income inequality measured by top income shares (Atkinson and Leigh, 2007). Third, Australia has experienced more frequent and intense commodity price shocks than many resource rich developing countries. Furthermore, Australia's GDP exposure to primary exports is far greater than that of many resource rich developing countries. Therefore, Australian experience could yield useful insights even for commodity-exporting poor countries. In fact, there are good reasons to think our findings can be generalized.

The analysis is conducted in four stages. First, the size and frequency of commodity price shocks and Australia's GDP exposure to primary exports are compared with the rest of the world over the periods 1865–1940 and 1960–2008. We find that Australia experienced more volatility and was exposed to primary products exports more than many commodity exporting developing countries. Second, we conduct Johansen cointegration tests to assess the commodity price shock and top income shares nexus and find that there is at least one cointegrated relationship in all models. Third, a single equation error correction model is estimated to quantify the effect of commodity price shocks on inequality, the latter measured by the income share of the top 1, 0.05, and 0.01 percent during 1921–2008. After controlling for GDP growth, interwar and wartime conditions, trade union density, direct tax shares in GDP, and enterprise wage bargaining, we find that commodity price shocks increased the income share of the top 1, 0.05, and 0.01 percent considerably. We also calculate the respective long run multipliers. Fourth, we examine the heterogeneous effects of wool, agricultural goods, and mining prices. Wool and mining prices have been the main drivers of Australian inequality in the short run. In the long run, however, high wool prices reduce inequality whereas high mining prices increase it.

The empirical literature on the inequality and resource boom connection is relatively thin. Three recent studies deal with this topic.[1] Gylfason and Zoega (2003) use a neoclassical model to demonstrate that natural resource dependence increases inequality and reduces growth. They verify their theoretical predictions using cross-sectional data. Goderis and Malone (2011) use a two-sector growth model with learning-by-doing to demonstrate how resource booms drive inequality. Using panel data covering 90 countries and the period 1965 to 1999, they argue that resource booms have a negative short-term effect but no long-term effect. In contrast, Ross (2007) uses a qualitative approach, outlining policies to reduce inequality in resource rich countries. Note that none of these studies analyze the effect of commodity price booms on distribution using very long time series data as we do here.

[1]For a review of the early research on this topic, see Aghion and Williamson (1998).

Our study also relates to a large literature on the economic consequences of volatility. These studies typically focus on terms of trade volatility and show that it has a negative impact on long run growth (Fatás and Mivhov, 2006; Blattman *et al.*, 2007; Koren and Tenreyro, 2007; Loayza *et al.*, 2007; Williamson, 2008, 2011; Poelhekke and van der Ploeg, 2009).[2] Blattman *et al.* (2007) exploit the period 1870–1939, and Williamson (2008) exploits the period 1780–1913, but all the other papers focus on the post-1960 decades.[3]

Our study is also related to a growing literature on inequality measurement, especially of top income shares (Atkinson and Leigh, 2007; Atkinson *et al.*, 2009; Roine *et al.*, 2009). These studies have documented income inequality using tax records, which in their view is an improvement over the earlier use of household consumption and income surveys. Atkinson *et al.* (2009) present an excellent survey of this literature.

Finally, our study is also related to the resource curse literature. Sachs and Warner (2001, 2005) argued that resource rich countries on average grow much slower than resource poor countries. Subsequent studies have shown that natural resources may lower the economic performance because they strengthen powerful groups and foster rent-seeking activities (e.g., Collier, 2000; Torvik, 2002). Others have argued that whether natural resources are a curse or a blessing depends on country-specific circumstances, especially institutional quality (Robinson *et al.*, 2006; Collier and Hoeffler, 2009; Bhattacharyya and Hodler, 2010; Bhattacharyya and Collier, 2014) and ethnic fractionalization (Hodler, 2006). Ross (2011) and van der Ploeg (2011) present exhaustive surveys of this literature.

Section 2 describes the data and how we measure commodity price and inequality in the long run. We also examine the extent to which the commodity price shocks experienced by Australia were greater in magnitude relative to the rest of the world. Section 3 introduces our empirical strategy to estimate the impact of commodity price shocks on top incomes and presents the results. Section 4 concludes.

2. A Century of Commodity Price Shocks and Inequality in Australia

2.1. *Data*

The aggregate commodity export price (P_X), commodity import price (P_M), and the GDP deflator (P_Y) are sourced from Bhattacharyya and Williamson (2011). These variables are annual time series running over the period 1890 to 2008. Bhattacharyya and Williamson (2011) compute export price as the weighted average of the export price of wool, minerals, and agricultural commodities. The export and import price data for the 1950 onwards period is readily available from the Reserve Bank of Australia's Historical Statistics database. Finding annual time series data for the 1890 to 1950 period is far more challenging, but

[2]Some of the early research on the impact of term of trade volatility on long-run growth are Ramey and Ramey (1995), Mendoza (1997), Deaton and Miller (1996), and Hadass and Williamson (2003).

[3]Using commodity price data since 1700, Jacks *et al.* (2011) show that globalization is associated with less commodity price volatility.

Bhattacharyya and Williamson (2011) address this challenge and also construct separate annual time series covering the 1890 to 2008 period for wool (P_{XW}), mining (P_{XM}), and agricultural commodities (P_{XA}), which we use here. The GDP deflator series is also annual and covers the period 1890 to 2008. While the price data cover 118 years, our regression results in Section 3 are limited to 1921–2008 when top income share data is available (Atkinson and Leigh, 2007). Finally, our control variables non-farm GDP growth, trade union density, and direct tax share are from Bhattacharyya and Hatton (2011).

2.2. *Measuring Commodity Price and Inequality in the Long Run*

The ratio of export to import prices (P_X/P_M), or the net barter terms of trade, is often used as a measure of commodity price movements. In order to assess the impact of these external price shocks on the economy as a whole, however, the prices of those two tradables should also be related to the prices of non-tradables. That is, a commodity export price boom (or bust) must be expressed relative to all other prices in the domestic economy in order to assess its impact on resource allocation and income distribution. Hence, a more effective measure is P_X/P_Y, which we use here and where P_Y is the GDP implicit price deflator.

Australia has undergone three major commodity price episodes over the past century (Figure 2).[4] The internal relative prices P_X/P_Y and P_M/P_Y show less volatility than the external terms of trade P_X/P_M, exactly what theory predicts (Dornbusch, 1974). The first half of the 1920s experienced a sharp increase in Australian commodity prices. The second major price shock occurred during the Korean War episode from the late 1940s to the early-mid 1950s and the third is what we have seen since 2003.[5] In terms of magnitude, the Korean War boom appears to be the more dramatic. The relative prices of wool, minerals, and agricultural goods are plotted in Figure 3. The 1920s boom was mainly driven by wool whereas the current boom has been driven by minerals. In contrast, the Korean War boom experienced relative price increases in all three commodity groups.

Inequality is measured by the income shares of the top 1, 0.05, and 0.01 percent of the richest Australians (Atkinson and Leigh, 2007).[6] The top income shares data, based on tax sources, have several advantages over household or income surveys (Atkinson *et al.*, 2009), but its most important advantage for Australia is that top income shares are available starting in 1921 while other inequality measures are not. Figure 4 shows that the most notable feature was the long run twentieth-century inequality decline, an event shared by almost all

[4]When Augmented Dickey–Fuller tests are performed on the price series, we do not find structural breaks. However, our plotted series clearly indicate the relative importance of the price shock episodes that we identify here.

[5]Bhattacharyya and Williamson (2011) provide a detailed historical account of these episodes.

[6]Like almost all studies exploring inequality, this one deals with nominal incomes. However, commodity price booms generate real exchange rate appreciation, a rise in non-tradable prices, and a fall in import prices. To the extent that top income groups spend a much higher share of their incomes on now-more-expensive non-tradable services, while the working class spends a larger share on now-cheaper imports, real income inequality may rise by less than nominal inequality. We do not pursue these issues here, but see Gregory and Sheehan (2013).

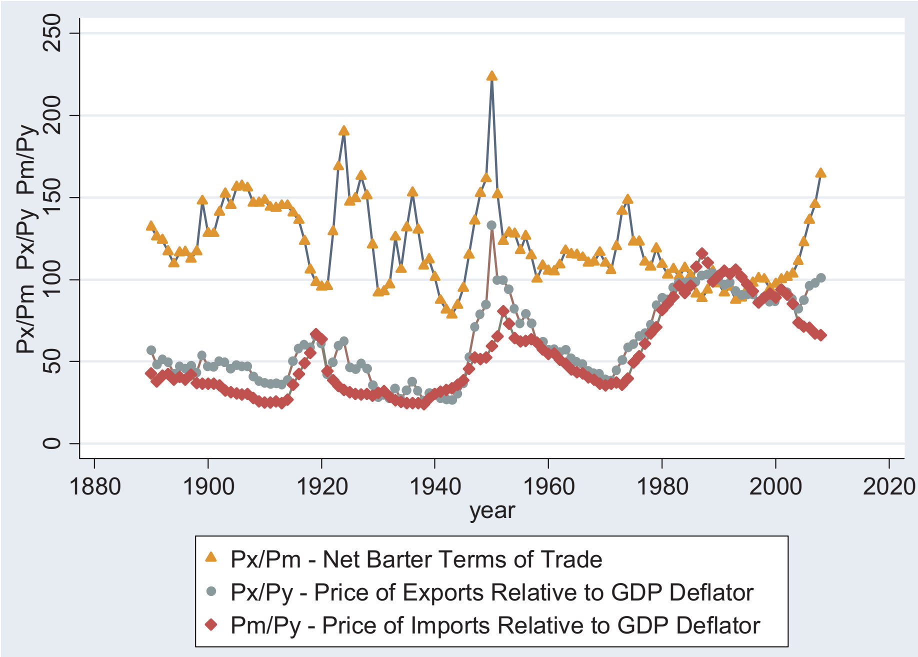

Figure 2. Australian Terms of Trade Time Series 1890–2008

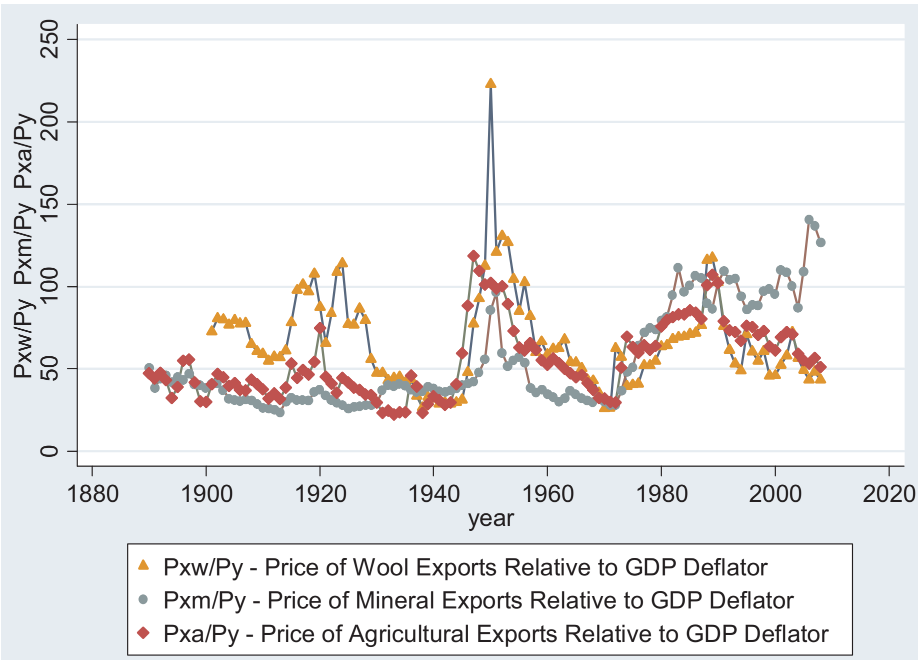

Figure 3. Export Prices of Wool, Mining, and Agriculture Relative to P_{GDP}

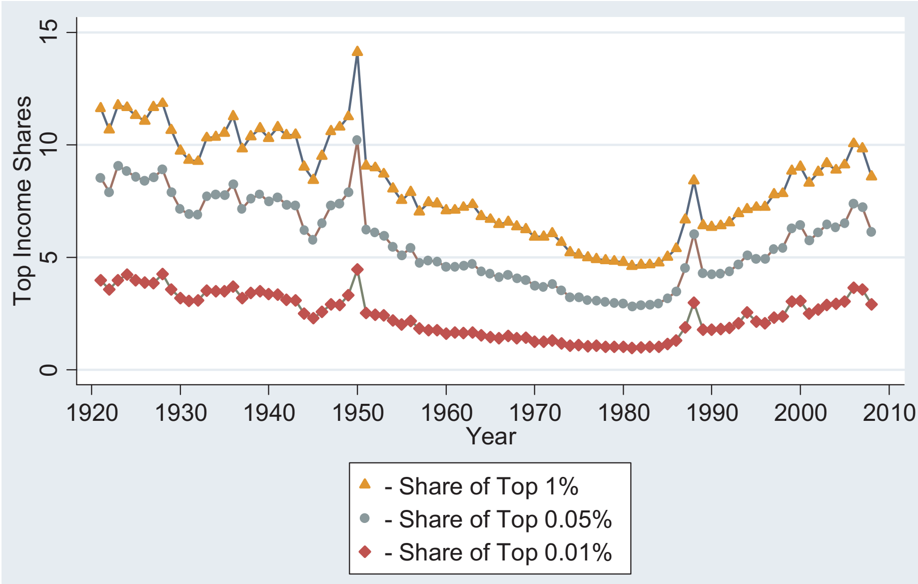

Figure 4. Income Share of the Top 1%, 0.05% and 0.01% since 1921

industrialized economies (Atkinson and Piketty, 2008; Gordon and Dew-Becker, 2008). The second notable feature is the rise in inequality across the 1980s and 1990s, again a feature shared by most industrialized economies. However, Australia recorded two other major departures from those long-run trends: the Korean War commodity price boom and bust, and the recent mining-led boom.

2.3. *Commodity Price Shocks and Dependence: Australia and the Rest of the World*

In order to explore the magnitude of the commodity price volatility experienced by Australia, we use the generalized autoregressive conditional heteroskedastic (GARCH) framework (Engle, 1982; Bollerslev, 1986). This robust approach to modeling time series volatility distinguishes between unconditional and conditional variance. It also incorporates a long memory in the data generating process by utilizing a flexible lag structure. In particular, the GARCH (p, q) specification assumes that the conditional variance equals

$$\sigma_t^2 = E(e_t^2 \mid \Omega_t) = \alpha + \sum_{i=1}^{p} \gamma_i e_{t-i}^2 + \sum_{i=1}^{q} \delta_j \sigma_{t-j}^2, \quad (1)$$

where e_t is the t^{th} error term from an autoregressive model. In other words, the conditional variance here depends on its own past values as well as lagged values of the residual term. We use GARCH (1,1), but even in this very parsimonious specification, and with annual data, commodity price volatility is well captured (Deb *et al.*, 1996).

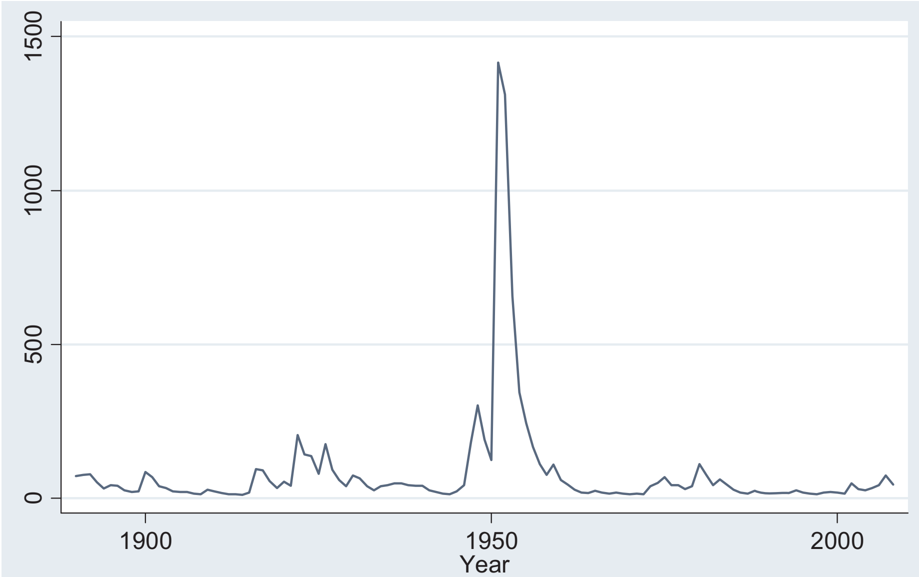

Figure 5. Conditional Variance of Australian Commodity Prices (*Px*/*Py*), 1890–2008

Figure 5 plots the conditional variance of Australian commodity prices P_X/P_Y covering the period 1890 to 2008. This involved a two-step procedure. First, the commodity price data was first differenced. Second, they were estimated as a GARCH (1,1) process and plotted over time. While there is no evidence of trend in commodity price volatility over time, the Korean War boom does stand out as the major volatility episode in Australian commodity price history. This finding is consistent with Jacks *et al.* (2011), who report an increase in commodity price volatility during wartime.

Next we explore Australian commodity price volatility relative to the rest of the world. Figure 6 compares its volatility with that of Indonesia, India, Canada, and the U.S. over the period 1865–1940, by plotting the ratio of conditional variances. If the ratio is greater than 1 it implies that Australia experienced more volatility than the country in question: parity in volatility between Australia and the country in question is signified by the horizontal line at the co-ordinate (0,1). On average, Australia experienced more volatility than India, Canada, and the U.S. Over the period 1920–40, Australia had significantly greater commodity price volatility than did such poor countries as Indonesia and India. This exercise is repeated in Figure 7 for Argentina, Brazil, Nigeria, and Canada for the period 1960–2008: Australian commodity price volatility has been greater than Canada and Nigeria, on par with Argentina, but less than Brazil. Therefore, we argue that there is a good case for our findings reported below to be generalizable for commodity exporting developing countries.

What about Australia's dependence on commodity exports as a share of aggregate income? Figure 8 (1865–1940) and Figure 9 (1965–2008) plot the primary exports share to GDP relative to the rest of the world. If the ratio is

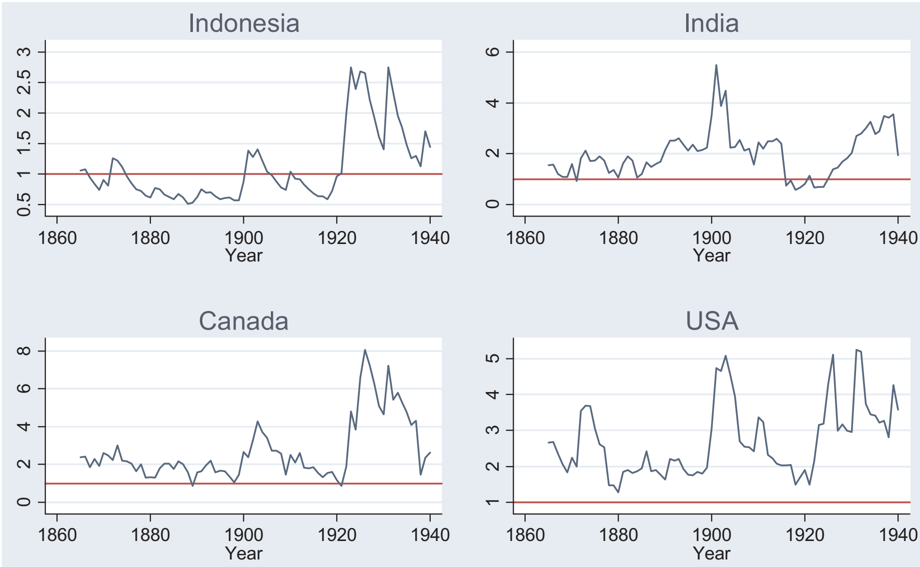

Figure 6. Ratio of Conditional Variances in Commodity Prices: Australia and the Rest of the World, 1865–1940

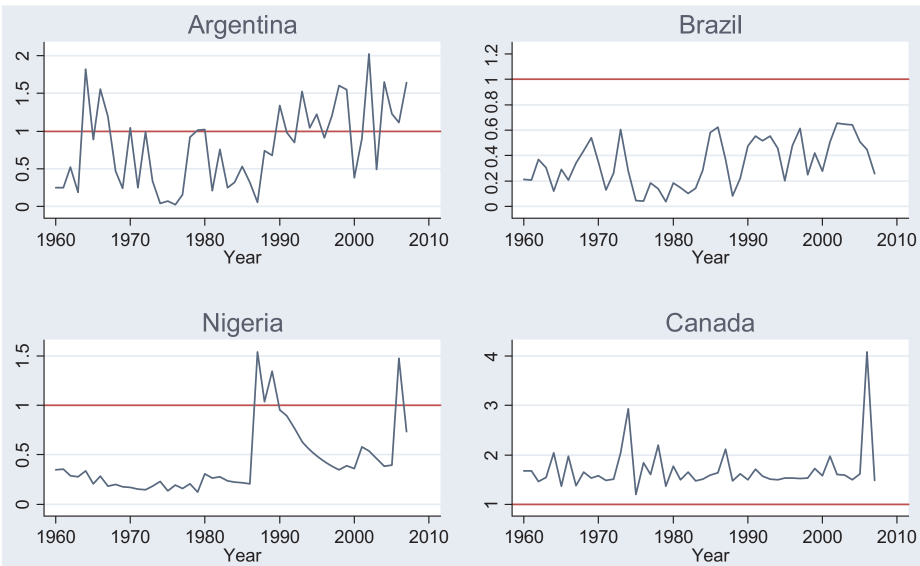

Figure 7. Ratio of Conditional Variances in Commodity Prices: Australia and the Rest of the World, 1960–2008

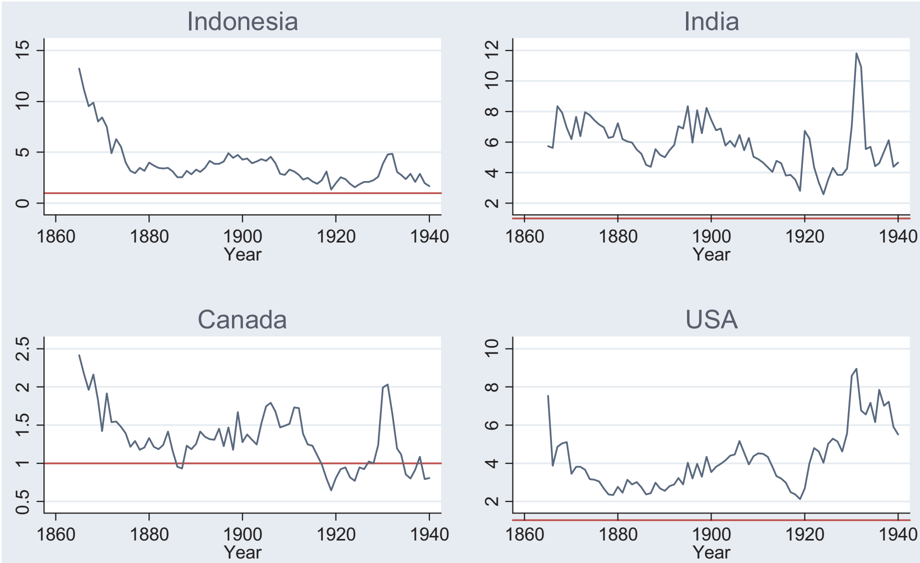

Figure 8. Ratio of the Primary Exports Share to GDP: Australia and the Rest of the World, 1865–1940

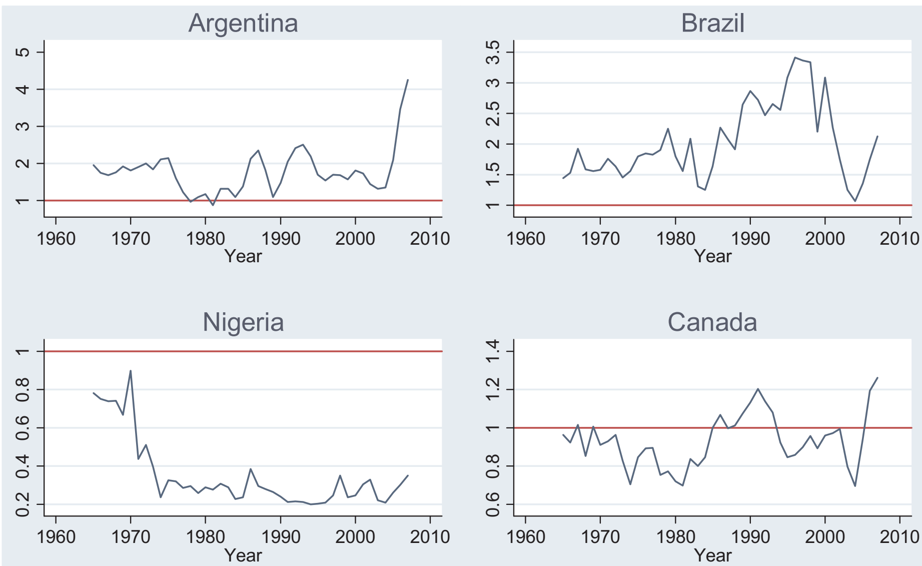

Figure 9. Ratio of the Primary Exports Share to GDP: Australia and the Rest of the World, 1965–2008

TABLE 1

Economic Fundamentals in Two Eras

Variables	1921–41 (1)	1941–2008 (2)	t-test (p-values) (3)
Income Share of the top 1%	10.72	7.43	7.56 (0.00)
Growth Rate of Real GDP	2.4	3.7	−1.68 (0.09)
Growth Rate of Real Wage	3.1	6.9	−3.71 (0.00)
Unemployment Rate	7.03	4.44	3.68 (0.00)
Structural Change Index based on Employment	5.8	2.3	5.21 (0.00)
Structural Change Index based on GDP	9.4	3.2	8.84 (0.00)
Trade Union Density	26.9	40.1	−6.39 (0.00)
Tax Share to GDP	2.5	11.6	−19.26 (0.00)

Notes: GDP, gross domestic product. Column (3) reports t-test to check whether the means reported in columns (1) and (2) are statistically significantly different. For variable definition and source, see Data Appendix.

greater than 1 it implies that commodity exports were more important to Australia than the country in question: parity between Australia and the country in question is signified by the horizontal line at the co-ordinate (0,1). On average, Australia's GDP was more exposed to commodity exports than Indonesia, India, Canada, and the U.S. between 1865 and 1940. From 1965 to 2008, Australia's GDP exposure to commodity exports was greater than that of Argentina or Brazil and on par with Canada. Only Nigeria had greater dependence on commodities. This evidence on dependence reinforces our argument that the Australian lesson should be useful for commodity exporting developing countries.

3. The Distributional Impact of Commodity Price Shocks

3.1. *Economic Fundamentals*

We now review the long term trends of some key variables that will be used in our econometric analysis. Table 1 reports means of these variables, and it is apparent that their history can be divided into two eras: 1921–41 and 1941–2008. The means are significantly different (Table 1, column 3), suggesting that they contained significantly different economic fundamentals. The first period includes the Great Depression and the run up to the Second World War, where the unemployment rate was so much higher and growth rate of GDP and real wages so much lower relative to the post-1941 period. In addition, inequality was much higher during the interwar years as was the case for most industrialized economies before inequality started falling in the 1930s, but especially after the Second World War and the rise of the welfare state. Trade union density was also significantly lower during 1921–41, consistent with wartime and post-war growth in manufacturing.

3.2. *Empirical Strategy*

Table 2 reports the unit root tests for all the major variables used here, applying both the adjusted Dickey–Fuller and Phillips–Perron approaches. All variables must be I(1) to perform Johansen cointegration tests, which is the case

TABLE 2
Unit Root Tests

	Adjusted Dickey–Fuller (ADF) Test		Phillips–Perron (PP) Test	
	Levels	First Differenced	Levels	First Differenced
$\ln(P_X/P_Y)_t$	−1.35	−9.74***	−6.92	−114.50***
$\ln(P_M/P_Y)_t$	−0.94	−6.45***	−4.56	−62.28***
$\ln(P_X/P_M)_t$	−1.09	−9.14***	−5.41	−93.12***
$\ln(P_{XW}/P_Y)_t$	−2.49	−9.62***	−9.59	−94.36***
$\ln(P_{XM}/P_Y)_t$	−0.57	−8.71***	−2.02	−79.77***
$\ln(P_{XA}/P_Y)_t$	−2.42	−9.18***	−11.95	−82.38***
$\ln(TIS1\%)_t$	−2.16	−11.26***	−6.21	−98.52***
$\ln(TIS0.05\%)_t$	−2.10	−11.23***	−5.69	−97.50***
$\ln(TIS0.01\%)_t$	−2.19	−10.85***	−6.11	−90.75***
$\ln(GDP)_t$	−1.45	−8.44***	−0.52	−93.39***

Notes: For ADF, Akaike Information Criteria (AIC) is used to select lag length and the maximum number of lags is set at five. For PP, Barlett–Kernel is used as the spectral estimation method. The bandwidth is selected using the Newey–West method. *, **, and *** indicate 10%, 5%, and 1% levels of significance, respectively. For variable definition and source, see Data Appendix.

TABLE 3
Johansen Cointegration Tests

	Trace Statistics (λ_{trace})				Maximum Eigenvalue Statistics ($\lambda_{\max}$)			
Models	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	$r = 0$	$r = 1$	$r = 2$	$r = 3$
[$\ln(TIS1\%)$, $\ln(P_X/P_Y)$, $GDPg$, $d21-41$]	55.65**	22.46	6.49	3.14	33.19**	15.96	3.34	3.15
[$\ln(TIS0.05\%)$, $\ln(P_X/P_Y)$, $GDPg$, $d21-41$]	32.79**	22.54	6.17	2.70	32.79**	16.39	3.46	2.70
[$\ln(TIS0.01\%)$, $\ln(P_X/P_Y)$, $GDPg$, $d21-41$]	55.39**	22.80	5.99	2.33	32.59**	16.81	3.66	2.34

Notes: Nested likelihood ratio tests on first differenced VARs were performed to determine the optimal lag length (p). The optimal lag length (p) is 1 for all models. The null hypothesis $r = 0$ implies that there is zero cointegration (or no cointegration) among variables. The trace statistics or the maximum eigenvalue statistics greater than the critical value implies rejecting the null $r = 0$ in favor of the alternative that there is cointegration. *, **, and *** indicate 10%, 5%, and 1% levels of significance, respectively. For variable definition and source, see Data Appendix.

here. Next, Johansen cointegration tests are performed to assess the commodity price shock and top income shares nexus. Since the Johansen approach is sensitive to the lag length used, we conduct a series of nested likelihood ratio tests on first-differenced VARs to determine the optimal lag length (p). The optimal lag length is one for all models. Cointegration tests are performed for each VAR model at levels. Both the trace and maximum eigenvalue tests in Table 3 unanimously point to the same conclusion that there is one cointegrated equation in all three models.

Having established the existence of a long run association between commodity price shocks and inequality, we now estimate the effect of commodity price shocks on inequality over our Australian century. We estimate the following single equation error correction model in equation (2):

$$\Delta \ln(TIS1\%)_t = \alpha + \beta_0 \Delta \ln(P_X / P_Y)_t + \beta_1 u_{1t-1} + \Phi \mathbf{X}_t + \varepsilon_t, \tag{2}$$

where $\Delta\ln(TIS1\%)_t$, $\Delta\ln(P_X/P_Y)_t$, $u_{1t-1} = [\Delta\ln(TIS1\%)_{t-1} - \alpha - \gamma_1 \ln(P_X/P_Y)_{t-1}]$ are the changes in log income share of the top 1 percent, the change in log commodity export price relative to the GDP deflator, and the error correction term, respectively. The model also includes a vector of control variables $\mathbf{X}_t$ containing the GDP growth rate and a dummy variable for the period 1921-19–41 (capturing the different economic fundamentals in that period).

The coefficient of interest is β_0 which captures the short-run relationship between commodity price shocks and top income shares. The coefficient β_1 on the error correction term estimates the speed at which the model returns to its long run equilibrium after a short run deviation. This coefficient should be negative and less than the absolute value of one to establish re-equilibrating properties. We use the Engle–Granger two step procedure whereby the estimated residual $\hat{u}_{1t-1}$ from the model $\ln(TIS1\%)_t = \alpha + \gamma_1 \ln(P_X/P_Y)_t + u_{1t}$ is used to estimate equation (2).[7]

3.3. *Commodity Price Shocks and Top Incomes*

Table 4 reports the impact of commodity price shocks on inequality in the short run, and column 1 reports an 0.31 elasticity: thus, a one percentage point increase in the commodity price growth rate leads to a 0.31 percentage point increase in the top share growth rate. This seems like a large effect to us given that the sample means are 10.7 and 7.4 percent in the two periods. The error correction term in column 1 is –0.06 and significant. Column 1 includes a dummy variable for 1921–41. As we argued above, this periodization is motivated by the economic fundamentals and history reported in Table 1. A more formal approach would be to conduct structural break tests. When a Zivot–Andrews structural break test is applied to $\Delta\ln(TIS1\%)_t$, a structural break is found for 1951. As a robustness check, therefore, we replace the 1921–41 dummy with a 1921–51 dummy in column 2. Our results remain unaffected.

Additional controls are added in columns 3 and 4. Column 3 adds war dummies for the Second World War and the Korean War. The coefficients are negative, suggesting a decline in inequality during the conflicts, presumably due to price and rent controls, government constraints on profits, and appeals to patriotism. However, the effects are not significant and our main result remains unaffected. Column 4 adds trade union density, the direct tax share in GDP, and an enterprise bargaining dummy as further controls. The signs on these coefficients suggest that during the post-war period the increase in trade union density and the tax share in GDP plus the introduction of enterprise bargaining (in 1997) might have reduced inequality.[8] However, none of the coefficients on these additional control variables are significant.

[7]Note that we also estimate the model using the Engle–Granger two step procedure without a linear trend in $\ln(TIS1\%)_t$ and the results are qualitatively identical.

[8]National wage decisions in Australia throughout the majority of the previous century were made via centralized wage setting institutions such as the Commonwealth Arbitration and Conciliation Court, Commonwealth Arbitration and Conciliation Commission, and Australian Industrial Relations Commission. This centralized wage setting process was significantly weakened by the introduction of enterprise bargaining in 1996/97.

TABLE 4

Commodity Price Shocks and Top Income Shares in Australia, 1921–2008: Main Econometric Results

	Dependent Variable: Change in Log Income Share of the Top 1 Percent [$\Delta\ln(TIS1\%)_t$]					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\ln(P_X/P_Y)_t$	0.31***	0.30***	0.32***	0.33***	0.31***	
	(0.09)	(0.09)	(0.09)	(0.10)	(0.08)	
$\Delta\ln(P_X/P_M)_t$						0.30**
						(0.12)
$\hat{u}_{1,t-1}$	–0.06***	–0.05***	–0.05**	–0.04**	–0.05**	
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	
$\hat{u}_{2,t-1}$						–0.07**
						(0.03)
GDP Growth Rate	0.48**	0.44**	0.47**	0.46**		0.17
	(0.19)	(0.20)	(0.18)	(0.20)		(0.21)
Non-Farm GDP Growth rate					0.36***	
					(0.12)	
Dummy 1921–41	0.04**		0.05**	0.04	0.07**	0.06*
	(0.02)		(0.02)	(0.05)	(0.03)	(0.03)
Dummy 1921–51		0.01				
		(0.02)				
Dummy Second World War (1939–45)			–0.04	0.02		
			(0.03)	(0.03)		
Dummy Korean War (1950–53)			–0.06	–0.01		
			(0.08)	(0.07)		
Log Trade Union Density$_{t-1}$				–0.11		
				(0.10)		
Log Direct Tax Share$_{t-1}$				–0.03		
				(0.06)		
Dummy Enterprise bargaining (1997–2008)				–0.01		
				(0.04)		
R^2	0.24	0.22	0.27	0.32	0.24	0.20
Durbin Watson	2.01	2.03	2.04	2.06	2.01	2.10
Durbin's Alternative test	0.80	0.75	0.34	0.55	0.91	0.45
Breusch–Godfrey LM test	0.79	0.74	0.32	0.52	0.87	0.43
Ramsey RESET test	0.19	0.13	0.20	0.29	0.18	0.19
Portmanteau white noise test	0.87	0.86	0.75	0.82	0.85	0.80
Number of observations	86	86	86	86	86	86

Notes: Figures in parentheses are robust standard errors and *, **, *** indicate 10%, 5%, and 1% levels of significance, respectively. For variable definition and source, see Data Appendix. Each column reports the Durbin Watson statistic which is approximately equal to $2(1 - r)$, where r is the sample autocorrelation of the residuals. Therefore a value close to 2 indicates no autocorrelation. The p-values of Durbin's Alternative test and Breusch–Godfrey LM test are also reported. Note that rejection of the null in these tests implies autocorrelation. The Portmanteau white noise tests for residuals are reported where the rejection of the null hypothesis implies that the residual is not a white noise process. Finally, p-values of Ramsey RESET test for omitted variables are also reported. A rejection of the null here implies the model suffers from omitted variable bias. Note that $\hat{u}_{1,t-1}$ and $\hat{u}_{2,t-1}$ are the error correction terms or estimated lagged residuals from the models $\ln(TIS1\%)_t = \alpha_1 + \gamma_1\ln(P_X/P_Y)_t + u_{1,t}$ and $\ln(TIS1\%)_t = \alpha_2 + \gamma_2\ln(P_X/P_M)_t + u_{2,t}$.

During the twentieth century, the non-farm sector was the engine of Australian growth (Maddock and McLean, 1987; Bhattacharyya and Williamson, 2011). Since the non-farm sector could have impacted income distribution differently than did the rest of the economy, column 5 replaces the GDP growth rate with the non-farm GDP growth rate. Similar to aggregate GDP growth, non-farm GDP growth also appears to increase inequality in the short run. In column 6, we replace $\Delta\ln(P_X/P_Y)_t$ by $\Delta\ln(P_X/P_M)_t$, the terms of trade measure. Our result remains qualitatively unchanged.

All columns in Table 4 report a battery of diagnostic tests, including the Portmanteau White Noise Test for residuals. These tests lend strong support to the statistical validity of our estimates.

3.4. *Top Income Share Response by Commodity Group*

Different natural resource exports might generate different development outcomes. Indeed, the resource curse literature suggests that countries exporting non-renewable resources (minerals, oil, and gas) are more adversely affected than countries exporting renewable natural resources such as agricultural commodities (Isham *et al.*, 2005; Bhattacharyya and Collier, 2014). But in high income and mature economies like Australia, more of the rents from extractive and non-renewable activities, such as mines and wells, accrue to the state. If the state implements progressive taxation and redistribution policies, some of these commodity-price-boom-induced rents will not serve to raise inequality. But some will, and that portion is higher the poorer the country and the weaker the government. In contrast, rents from agriculture, forestry, and the pastoral economy accrue largely to local households and firms. They are, by definition, also sustainable. Hence, we might expect a substantially smaller proportion of these rents to be redistributed and thereby to increase inequality (depending on the initial distribution of land, of course). Table 5 resolves these theoretical ambiguities. There we report that it is mining (column 1) and wool (column 3) price booms that have increased Australian top income shares, at least in the short run. The effect of a change in the relative price of agricultural commodities (column 2) is positive but statistically insignificant. Column 4 tests the significance of these coefficients when they are all included in the same model, and the positive effects of wool and mining prices survive.

We conclude that wool and mining price booms increase top incomes in the short run, but agricultural commodity price shocks do not. We shall explore below whether the long run effects are the same.

3.5. *Commodity Price Shocks and the Very Top Incomes*

So far we have focused on the income share of the top 1 percent. In this section we check whether there is any heterogeneity in response within different top income shares. Table 6 reports the impact of a commodity price shock on the income share of the top 0.05 and 0.01 percent shares. Column 1 shows that the effect of a commodity price shock on the change in log income share of the top 0.05 percent [$\Delta\ln(TIS0.05\%)_t$] is positive, statistically significant, and has a coefficient estimate of 0.33, which is a bit bigger than the 0.31 estimate for the top 1 percent (Table 4, column 1). This implies that the beneficiaries of a commodity price shock are at the very top end of the income distribution. In the absence of data, we can only speculate that these are the owners of natural resources in the export sector. Column 2 corroborates the hypothesis: when the dependent variable is changed to

TABLE 5

Varieties of Commodities and Top Income Shares in Australia, 1921–2008

	Dependent Variable: Change in Log Income Share of the Top 1 Percent [$\Delta\ln(TIS1\%)_t$]			
	(1)	(2)	(3)	(4)
$\Delta\ln(P_{XW}/P_Y)_t$	0.19***			0.20**
	(0.06)			(0.09)
$\Delta\ln(P_{XA}/P_Y)_t$		0.01		–0.05
		(0.05)		(0.06)
$\Delta\ln(P_{XM}/P_Y)_t$			0.14***	0.13**
			(0.04)	(0.06)
$\hat{u}_{W,t-1}$	–0.08**			–0.02
	(0.03)			(0.03)
$\hat{u}_{A,t-1}$		–0.06		–0.05
		(0.07)		(0.05)
$\hat{u}_{M,t-1}$			–0.04**	–0.04
			(0.016)	(0.05)
GDP Growth Rate	0.42***	0.38*	0.46***	0.43***
	(0.15)	(0.22)	(0.17)	(0.15)
Dummy 1921–41	0.04*	0.02	0.07*	0.08**
	(0.02)	(0.03)	(0.03)	(0.039)
R^2	0.30	0.05	0.24	0.31
Durbin Watson	2.01	2.17	2.03	2.01
Durbin's Alternative test	0.82	0.36	0.78	0.78
Breusch–Godfrey LM test	0.81	0.34	0.77	0.76
Ramsey RESET test	0.18	0.21	0.18	0.19
Portmanteau white noise test	0.53	0.80	0.73	0.54
Number of observations	86	86	86	86

Notes: Figures in parentheses are robust standard errors and *, **, *** indicate 10%, 5%, and 1% levels of significance, respectively. For variable definition and source,see Data Appendix. Each column reports the Durbin Watson statistic which is approximately equal to $2(1 - r)$, where r is the sample autocorrelation of the residuals. Therefore a value close to 2 indicates no autocorrelation. The p-values of Durbin's Alternative test and Breusch–Godfrey LM test are also reported. Note that rejection of the null in these tests implies autocorrelation. The Portmanteau white noise tests for residuals are reported where the rejection of the null hypothesis implies that the residual is not a white noise process. Finally, p-values of Ramsey RESET test for omitted variables are also reported. A rejection of the null here implies the model suffers from omitted variable bias. Note that $\hat{u}_{W,t-1}$, $\hat{u}_{A,t-1}$ and $\hat{u}_{M,t-1}$ are the error correction terms or estimated lagged residuals from the models $\ln(TIS1\%)_t = \alpha_3 + \gamma_3\ln(P_{XM}/P_Y)_t + u_{W,t}$, $\ln(TIS1\%)_t = \alpha_4 + \gamma_4\ln(P_{XA}/P_Y)_t + u_{A,t}$ and $\ln(TIS1\%)_t = \alpha_5 + \gamma_5\ln(P_{XM}/P_M)_t + u_{M,t}$.

the log income share of the top 0.01 percent [$\Delta\ln(TIS0.01\%)_t$], the estimated coefficient on $\Delta\ln(P_X/P_Y)_t$ increases to 0.39 and is strongly significant. Still, we should stress that none of these estimated coefficients are significantly different from the initial estimate of 0.31.

3.6. *The Long Run Effects of Commodity Price Booms*

Table 7 explores the long run equilibrium relationship between commodity price and income distribution. It is done using the one step procedure. One could rewrite equation (2) as the following model:

$$(3)\quad \Delta\ln(TIS1\%)_t = \lambda_0 + \lambda_1\Delta\ln(P_X/P_Y)_t + \lambda_2\ln(TIS1\%)_{t-1} + \lambda_3\ln(P_X/P_Y)_{t-1} + \upsilon_t.$$

TABLE 6

Commodity Price Shocks and the very Top in Australia, 1921–2008

	Change in Log Income Share of the Top 0.05 Percent $[\Delta\ln(TIS0.05\%)_t]$ (1)	Change in Log Income Share of the Top 0.01 Percent $[\Delta\ln(TIS0.01\%)_t]$ (2)
$\Delta\ln(P_X/P_Y)_t$	0.33***	0.39***
	(0.10)	(0.11)
$\hat{u}_{05,t-1}$	–0.07***	
	(0.02)	
$\hat{u}_{01,t-1}$		–0.06***
		(0.02)
GDP Growth Rate	0.49**	0.54**
	(0.21)	(0.27)
Dummy 1921–41	0.12**	0.07**
	(0.05)	(0.03)
R^2	0.21	0.15
Durbin Watson	2.03	2.01
Durbin's Alternative test	0.80	0.88
Breusch-Godfrey LM test	0.79	0.87
Ramsey RESET test	0.31	0.13
Portmanteau white noise test	0.84	0.74
Number of observations	86	86

Notes: Figures in parenthesies are robust standard errors and *, **, *** indicate 10%, 5%, and 1% levels of significance, respectively. For variable definition and source, see Data Appendix. Each column reports the Durbin Watson statistic which is approximately equal to $2(1 - r)$, where r is the sample autocorrelation of the residuals. Therefore a value close to 2 indicates no autocorrelation. The p-values of Durbin's Alternative test and Breusch–Godfrey LM test are also reported. Note that rejection of the null in these tests implies autocorrelation. The Portmanteau white noise tests for residuals are reported where the rejection of the null hypothesis implies that the residual is not a white noise process. Finally, p-values of Ramsey RESET test for omitted variables are also reported. A rejection of the null here implies the model suffers from omitted variable bias. Note that $\hat{u}_{05,t-1}$ and $\hat{u}_{01,t-1}$ are the error correction terms or estimated lagged residuals from the models $\ln(TIS0.05\%)_t = \alpha_6 + \gamma_6\ln(P_X/P_Y)_t + u_{05,t}$ and $\ln(TIS0.01\%)_t = \alpha_7 + \gamma_7\ln(P_X/P_M)_t + u_{01,t}$.

TABLE 7

Commodity Price Shocks and the very Top in Australia: Long Run Effects

	Log Income Share of the Top 1 Percent $[\Delta\ln(TIS1\%)_t]$				Log Income Share of the Top 0.05 Percent $[\Delta\ln(TIS0.05\%)_t]$	Log Income Share of the Top 0.01 Percent $[\Delta\ln(TIS0.01\%)_t]$
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(P_X/P_Y)_t$	0.5***				0.71***	0.87***
	(0.04)				(0.07)	(0.06)
$\ln(P_{XW}/P_Y)_t$		–0.13***				
		(0.03)				
$\ln(P_{XM}/P_Y)_t$			0.38***			
			(0.06)			
$\ln(P_{XA}/P_Y)_t$				–0.02		
				(0.04)		

Notes: Figures in parentheses are robust standard errors and *, **, *** indicate 10%, 5%, and 1% levels of significance, respectively. For variable definition and source, see Data Appendix. These are long run effects (or long run multiplier) calculated using the one-step procedure described in the text.

This model is in long run equilibrium and where $\Delta\ln(TIS1\%)_t = \Delta\ln(P_X/P_Y)_t = \upsilon_t = 0$ and $\ln(TIS1\%)_{t-1} = \ln(TIS1\%)^*$, and $\ln(P_X/P_Y)_{t-1} = \ln(P_X/P_Y)^*$, where $\ln(TIS1\%)^*$ and $\ln(P_X/P_Y)^*$ are long run steady state values. Then the long run multiplier effect is $-\frac{\lambda_3}{\lambda_2}$ and the corresponding variance is $\frac{1}{\lambda_2^2}\mathrm{var}(\lambda_3)+\frac{\lambda_3^2}{\lambda_2^4}\mathrm{var}(\lambda_2)-2\left(\frac{\lambda_3}{\lambda_2^3}\right)\mathrm{cov}(\lambda_3,\lambda_2)$ which could be easily calculated from the variance covariance matrix.

Column 1 of Table 7 estimates the long run equilibrium relationship between $\ln(TIS1\%)_t$ and the overall commodity price $\ln(P_X/P_Y)_t$: the effect is positive and significant. In the long run, the rich gain disproportionately more from an increase in commodity prices compared with the rest of the population, thereby increasing inequality. Columns 2–4 report the long run impact of wool, minerals, and agriculture prices separately. We find that a sustained increase in wool prices benefits the rest of the society more than the top: wool price booms reduce inequality in the long run. In contrast, a prolonged mining or petroleum price boom enriches the top of the income distribution more than the rest of country. The effect of an increase in the prices of agricultural commodities is not statistically significant. These results are consistent with the resource curse literature (Isham *et al.*, 2005; Bhattacharyya and Collier, 2014). No doubt this result is likely to be driven in large part by the fact that farmland is distributed more equally than mineral resource ownership, especially in "regions of recent settlement" dominated by the family farm (Engerman and Sokoloff, 1997).

Columns 5 and 6 explore the long run relationship between the overall commodity price $\ln(P_X/P_Y)_t$ on both $\Delta\ln(TIS0.05\%)_t$ and $\Delta\ln(TIS0.01\%)_t$. The effect is positive and significant in both cases, and the magnitude of the long term effect also increases from 0.5 in column 1, to 0.71 in column 5, and to 0.87 in column 6. This result offers further support for the hypothesis that a sustained increase in commodity price benefits the very top more than the rest of the society.

4. Concluding Remarks

Studies of the distributional impact of commodity price shocks over the very long run are rare. Being a major commodity exporting country with good time series data, makes Australia the perfect candidate for an assessment of the inequality and commodity price boom connection. This paper investigates the effects of resource booms on income distribution in Australia over the century from 1921 to 2008. We find that Australia experienced more volatility than many commodity exporting developing countries during the periods 1865–1940 and 1960–2008. Australia also had greater GDP exposure to commodity exports than many resource rich developing countries. Johansen's cointegration test reveals a long run association between commodity price shocks and inequality. Commodity price shocks increased the income share of the top 1, 0.05, and 0.01 percent in the short run. The effect is robust after controlling for GDP growth, interwar and war, trade union density, direct tax shares in GDP, and enterprise wage bargaining. The short run effect is heterogeneous across different commodity groups as it is driven mainly by wool and mining and not agricultural commodities. The very top end of the income distribution (the top 0.05 and 0.01 percent) benefit from commodity booms disproportionately more than the rest of the society.

We also look at the long run equilibrium relationship between commodity price and top incomes. All top income groups (1, 0.05, and 0.01 percent) benefit from a sustained increase in commodity prices. The very top groups (0.05 and 0.01 percent) benefit more than the top 1 percent, suggesting that the owners of land and mineral resources in the commodity sector inhabit the very top end of the income distribution. Sustained price increase in renewables such as wool reduces inequality whereas the same in non-renewable resources such as minerals and petroleum increases inequality. Agriculture does not seem to have any effect, perhaps because land used for that purpose is distributed much more equally.

Even though Australia is a developed commodity exporting country, the price volatility it experienced and the exposure it has had to commodities was greater than the average commodity exporting low income country. Thus, studying the distributional impact of commodity price shocks in Australia (and also Canada and New Zealand) could yield important lessons for primary producers from the developmental south. In short, our analysis seems timely and relevant, not just for Australia, but for all resource rich developing countries.

Our analysis shows that resource booms tend to exacerbate inequality. The recent literature on the economic consequences of inequality argues that high and persistent inequality not only harms growth but also adversely affects institutions (Engerman and Sokoloff, 1997, 2012; Aghion *et al.*, 1999; Acemoglu *et al.*, 2005; Acemoglu and Robinson, 2006, 2012). Therefore, it is important for resource rich developing countries to design appropriate policies to tackle inequality that emerges as a consequence of commodity export booms. Whether their political economy makes that possible is, of course, less likely than for mature economies like Australia. Thus, we hope that future research will seek good time series data from developing countries to see whether the magnitudes of impact are bigger than what we find for Australia as the political economy literature would predict.

Data Appendix

Commodity Export Price relative to GDP deflator (P_X/P_Y): Weighted average of export price of wool, minerals, and agricultural commodities relative to GDP deflator over the period 1890–2008. *Source*: Bhattacharyya and Williamson (2011).

Export Price of wool relative to GDP deflator (P_{XW}/P_Y): Weighted average of wholesale export price of wool in New South Wales and Victoria relative to GDP deflator over the period 1890–2008. Production of greasy wool is used as weights. *Source*: Bhattacharyya and Williamson (2011).

Export Price of mining relative to GDP deflator (P_{XM}/P_Y): Weighted average of export price of metals (silver, copper, tin, zinc, lead, gold) and coal relative to GDP deflator over the period 1890–2008. Production of metals and coal is used as weights. *Source*: Bhattacharyya and Williamson (2011).

Export Price of agricultural commodities relative to GDP deflator (P_{XA}/P_Y): Weighted average of export price of agricultural commodities (wheat, cereals, forestry, and fisheries) relative to GDP deflator over the period 1890–2008. Production of these commodities is used as weights. *Source*: Bhattacharyya and Williamson (2011).

Import Price relative to GDP deflator (P_M/P_Y): Import price index commodities relative to GDP deflator over the period 1890–2008. *Source*: Bhattacharyya and Williamson (2011).

Income Shares of the top 1%, 0.05%, 0.01% [(*TIS*1%), (*TIS*0.05%), (*TIS*0.01%)]: *Source*: Atkinson and Leigh (2007).

Commodity Export Price for Canada, Indonesia, India, and U.S. for the period 1865–1940: These prices are used in Figure 5. *Source*: Blattman *et al*. (2007).

Commodity Export Price for Argentina, Brazil, Canada, and Nigeria for the period 1960–2008: These prices are used in Figure 6. *Source*: Burke and Leigh (2010).

GDP Growth Rate: Growth rate calculated using real GDP (measured at 1990 constant prices). *Source*: Bhattacharyya and Williamson (2011).

Non-Farm GDP Growth Rate: Growth rate calculated using real Non-Farm GDP (measured at 1990 constant prices). *Source*: Bhattacharyya and Hatton (2011).

Trade Union Density: Defined as trade union membership as a proportion of employment. *Source*: Bhattacharyya and Hatton (2011).

Direct Tax Share: Share of Income Tax to Nominal GDP. *Source*: Bhattacharyya and Hatton (2011).

Primary Exports Share to GDP (1865–1940): Share of primary products exports to GDP for the period 1865–1940 used in Figure 8. *Source*: Clemens and Williamson (2004).

Primary Exports Share to GDP (1965–2008): Share of primary products exports to GDP for the period 1965–2008 used in Figure 9. *Source*: The World Bank.

References

Acemoglu, D. and J. Robinson, "De Facto Political Power and Institutional Persistence," *American Economic Review*, 96, 325–30, 2006.

———, *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*, Cromn Publishers, New York, 2012.

Acemoglu, D., S. Johnson, and J. Robinson, "Institutions as the Fundamental Cause of Long-Run Growth," *Handbook of Economic Growth*, 1, 385–472, 2005.

Aghion, P. and J. G. Williamson, *Growth, Inequality and Globalization: Theory, History and Policy*, Cambridge University Press, Cambridge, 1998.

Aghion, P., E. Caroli, and C. Garcia-Penalosa, "Inequality and Economic Growth: The Perspective of the New Growth Theories," *Journal of Economic Literature*, 37, 1615–60, 1999.

Atkinson, A. and A. Leigh, "The Distribution of Top Incomes in Australia," *Economic Record*, 83(262), 247–61, 2007.

Atkinson, A. and T. Piketty, *Top Incomes Over the Twentieth Century: A Contrast Between Continental European and English-Speaking Countries*, Oxford University Press, Oxford, 2008.

Atkinson, A., T. Piketty, and E. Saez, "Top Incomes in the Long Run of History," NBER Working Paper No. 15408, October 2009.

Bhattacharyya, S. and P. Collier, "Public Capital in Resource Rich Economies: Is there a Curse?" *Oxford Economic Papers*, 66(1), 1–24, 2014.

Bhattacharyya, S. and T. J. Hatton, "Australian Unemployment in the Long Run, 1903–2007," *Economic Record*, 87(277), 202–20, 2011.

Bhattacharyya, S. and R. Hodler, "Natural Resources, Democracy and Corruption," *European Economic Review*, 54, 608–21, 2010.

Bhattacharyya, S. and J. G. Williamson, "Commodity Price Shocks and the Australian Economy since Federation," *Australian Economic History Review*, 51, 150–77, 2011.

Blattman, C., J. Hwang, and J. G. Williamson, "The Impact of the Terms of Trade on Economic Development in the Periphery, 1870–1939: Volatility and Secular Change," *Journal of Development Economics*, 82, 156–79, 2007.

Bollerslev, T., "Generalized Autoregressive Conditional Heteroskedasticity," *Journal of Econometrics*, 31, 307–27, 1986.

Burke, P. J. and A. Leigh, "Do Output Contractions Trigger Democratic Change?" *American Economic Journal: Macroeconomics*, 2, 124–57, October 2010.

Clemens, M. and J. G. Williamson, "Why did the Tariff-Growth Correlation Change after 1950?" *Journal of Economic Growth*, 9, 5–46, 2004.

Collier, P., "Ethnicity, Politics and Economic Performance," *Economics and Politics*, 12, 225–45, 2000.

Collier, P. and A. Hoeffler, "Testing the Neocon Agenda: Democracy in Resource-Rich Societies," *European Economic Review*, 53, 293–308, 2009.

Corden, W. M. and J. P. Neary, "Booming Sector and De-Industrialization in a Small Open Economy," *Economic Journal*, 92, 825–48, 1982.

Deaton, A. and R. I. Miller, "International Commodity Prices, Macroeconomic Performance and Politics in Sub-Saharan Africa," *Journal of African Economies*, 5(Supplement), 99–191, 1996.

Deb, P., P. Trivedi, and P. Varangis, "The Excess Co-Movement of Commodity Prices Reconsidered," *Journal of Applied Econometrics*, 11, 275–91, 1996.

Dornbusch, R., "Tariffs and Nontraded Goods," *Journal of International Economics*, 4, 177–85, 1974.

Engerman, S. L. and K. L. Sokoloff, "Factor Endowments, Inequality, and Differential Paths of Growth Among New World Economies," in S. Haber (ed.), *How Latin America Fell Behind*, Stanford University Press, Stanford, CA, 260–304, 1997.

———, *Economic Development in the Americas since 1500: Endowments and Institutions*, Cambridge University Press, New York, 2012.

Engle, R., "Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of United Kingdom Inflation," *Econometrica*, 31, 307–27, 1982.

Fatás, A. and I. Mivhov, "Policy Volatility, Institutions and Economic Growth," INSEAD, Singapore and Fontainebleau, France, 2006.

Goderis, B. and S. Malone, "Natural Resource Booms and Inequality: Theory and Evidence?" *Scandinavian Journal of Economics*, 113, 388–417, 2011.

Gordon, R. J. and I. Dew-Becker, "Controversies about the Rise of American Inequality: A Survey," NBER Working Paper No. 13982, National Bureau of Economic Research, Cambridge, MA, April 2008.

Gregory, R., "Some Implications of the Growth of the Mining Sector," *Australian Journal of Agricultural Economics*, 20, 71–91, August 1976.

Gregory, R. and P. Sheehan, "The Resources Boom and Economic Policy in the Longer Run," CEPR Discussion Paper No. 683, Centre for Economic Policy Research, March 2013.

Gylfason, T. and G. Zoega, "Inequality and Economic Growth: Do Natural Resources Matter?" in T. Eicher and S. Turnovsky (eds), *Inequality and Growth: Theory and Policy Implications*, MIT Press, Cambridge, MA and London, 255–92, 2003.

Hadass, Y. and J. G. Williamson, "Terms-of-Trade Shocks and Economic Performance, 1870–1940: Prebisch and Singer Revisited," *Economic Development and Cultural Change*, 51, 629–56, 2003.

Hodler, R., "The Curse of Natural Resources in Fractionalized Countries," *European Economic Review*, 50, 1367–86, 2006.

Isham, J., L. Pritchett, M. Woolcock, and G. Busby, "The Varieties of Resource Experience: Natural Resource Export Structures and the Political Economy of Economic Growth," *World Bank Economic Review*, 19, 141–74, 2005.

Jacks, D., K. O'Rourke, and J. G. Williamson, "Commodity Price Volatility and World Market Integration since 1700," *Review of Economics and Statistics*, 93, 800–13, 2011.

Koren, M. and S. Tenreyro, "Volatility and Development," *Quarterly Journal of Economics*, 122, 243–87, 2007.

Loayza, N. V., R. Rancière, L. Servén, and J. Ventura, "Macroeconomic Volatility and Welfare in Developing Countries: An Introduction," *World Bank Economic Review*, 21, 343–57, 2007.

Maddock, R. and I. McLean, *The Australian Economy in the Long Run*, Cambridge University Press, Cambridge, 1987.

Mendoza, E., "Terms of Trade Uncertainty and Economic Growth," *Journal of Development Economics*, 54, 323–56, 1997.

Poelhekke, S. and F. van der Ploeg, "Volatility and the Natural Resource Curse," *Oxford Economic Papers*, 61, 727–60, 2009.

Ramey, G. and V. Ramey, "Cross-Country Evidence on the Link between Volatility and Growth," *American Economic Review*, 85, 1138–51, 1995.
Robinson, J., R. Torvik, and T. Verdier, "Political Foundations of the Resource Curse," *Journal of Development Economics*, 79, 447–68, 2006.
Roine, J., J. Vlachos, and D. Waldenstrom, "The Long Run Determinants of Inequality: What Can We Learn from Top Income Data?" *Journal of Public Economics*, 93, 974–88, 2009.
Ross, M., "How Can Mineral Rich States Reduce Inequality?" in J. Sachs, J. Stiglitz, and M. Humphreys (eds), *Escaping the Resource Curse*, Columbia University Press, New York, 2007.
———, *The Oil Curse: How Petroleum Wealth Shapes the Development of Nations*, Princeton University Press, Princeton, NJ, 2011.
Sachs, J. and A. Warner, "The Curse of Natural Resources," *European Economic Review*, 45, 827–38, 2001.
———, "Natural Resource Abundance and Economic Growth," in G. Meier and J. Rauch (eds), *Leading Issues in Economic Development*, Oxford University Press, New York, 161–7, 2005.
Torvik, R., "Natural Resources, Rent Seeking and Welfare," *Journal of Development Economics*, 67, 455–70, 2002.
van der Ploeg, F., "Natural Resources: Curse or Blessings?" *Journal of Economic Literature*, 49, 366–420, 2011.
Williamson, J. G., "Globalization and the Great Divergence: Terms of Trade Booms and Volatility in the Poor Periphery 1782–1913," *European Review of Economic History*, 12, 355–91, December 2008.
———, *Trade and Poverty: When the Third World Fell Behind*, MIT Press, Cambridge, MA, 2011.