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Federal Legislative Activism in Australia: A New Approach to Testing Wagner's Law

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Abstract: Legislation is an important output of the political process. Growth in legislation can serve as a proxy for growth in the size and role of government, side-stepping some of the endogeneity problems encountered in estimating relationships between government spending and revenue and national income. This paper considers the relationship between government growth and real GDP per capita by developing three models of federal legislative output in Australia since the country's founding in 1901. The models explain growth in (1) the number of acts of parliament; (2) the total number of pages of legislation enacted; and (3) a measure of legislative complexity based on the annual average number of pages per act. The growth in the number of acts is found to be negatively related to growth in real national income per capita in the short-run, implying that legislative output responds to temporary economic shocks, but without a robust long-run relationship with the level of income. The growth in the number of pages of legislation enacted and legislative complexity also show a negative short-run relationship with growth in real national income per capita, but a positive long-run relationship with the level of income that is consistent with Wagner's (1890) law of 'increasing state activity.' However, both the short and long-run relationships are statistically significant only for the post-World War II period, raising questions about the general applicability of Wagner's law.

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1. Introduction

Growth in government as a share of national income has been a stylised fact for most developed economies since the beginning of the 20th century. Buchanan's (1977, 5) taxonomy of theories of government growth divides them broadly into models of 'government by the people' and 'government against the people.' Within the former category are models suggested by Wagner's (1890) law of 'increasing state activity,' which maintains a positive relationship between the size of government and long-run economic development as proxied by real GDP per capita. Wagner's 'law' has no definitive formulation (Peacock and Scott 2000), but in empirical settings is often interpreted as an income elasticity of growth in government greater than one, thereby accounting for growth in the government share of national income over time.

Previous efforts at testing Wagner's law have focused on the relationship between government spending or taxation and national income in both cross-sectional and time series settings (see e.g., Ram 1987; Easterly and Rebelo 1993; Oxley 1994), with mixed results. Durevall and Henrekson's (2010, 4) review of the literature finds that 35% of studies obtain unqualified support for Wagner's law, 35% fail to find support, while 30% find support conditioning on other variables or specific categories of government spending. Empirical tests of Wagner's law in the Australian context have been inconclusive (Dollery and Singh 2000; Chang, Liu, and Caudill 2004). Lindert (1996) has characterised 'the notion that income growth will raise taxes and government spending, including social spending [as] the most durable black box in the whole rise-of-the-state literature.' Potential endogeneity between government spending, revenue and economic growth has been a significant complication for empirical work. There are often substantial series or structural breaks in public sector accounts. Government spending and taxing may also be incomplete as a description of the size, scope and role of government.

This paper takes a new approach to the issue of government growth by developing three models of federal legislative output in Australia since the country's founding in 1901. Acts of federal parliament are among the most important outputs of the political process. New federal government policy initiatives and programs typically require enabling legislation, so the growth in federal legislation serves as a proxy for growth in government and may capture elements of both the size and scope of government. It should be noted that particular legislation could also reduce the role of government. For example, many deregulatory policies, tax reform and other economic liberalisation measures may require new laws or amendments to existing legislation to give effect to these policies. However, the expansion in the government expenditure and revenue shares of GDP over time implies that Australian government policies have generally expanded rather than reduced the role of government.

Particular legislation may help, hinder or be irrelevant to overall economic activity, but total legislative output would not be expected to have systematic implications for national income. This is a useful property, in that we can make a plausible theoretical case that legislative output responds to contemporaneous or lagged national income along the lines suggested by Wagner's law, but that legislation in aggregate does not determine real GDP per capita. The growth in federal legislation may capture elements of growth in government not otherwise reflected in measures of government spending and revenue, while side-stepping some of the endogeneity issues that can arise in estimating relationships between these fiscal variables and national income.

This paper estimates three models that seek to explain growth in (1) the number of acts of parliament; (2) the total number of pages of legislation enacted; and (3) a measure of legislative complexity based on the annual average number of pages per act. The growth in the number of acts is found to be negatively related to growth in real GDP per capita in the short-run, but with little support for a long-run relationship with the level of real national income per capita. This implies that the legislative process responds to temporary economic shocks, with negative shocks leading to increased legislative output. The growth in pages of legislation enacted and legislative complexity also show a negative short-run relationship with growth in real national income per capita, but a positive long-run relationship with the level of income that is consistent with Wagner's law. However, the results for all three models are robust only for the post-World War II period. A concluding section considers some of the implications of these results.

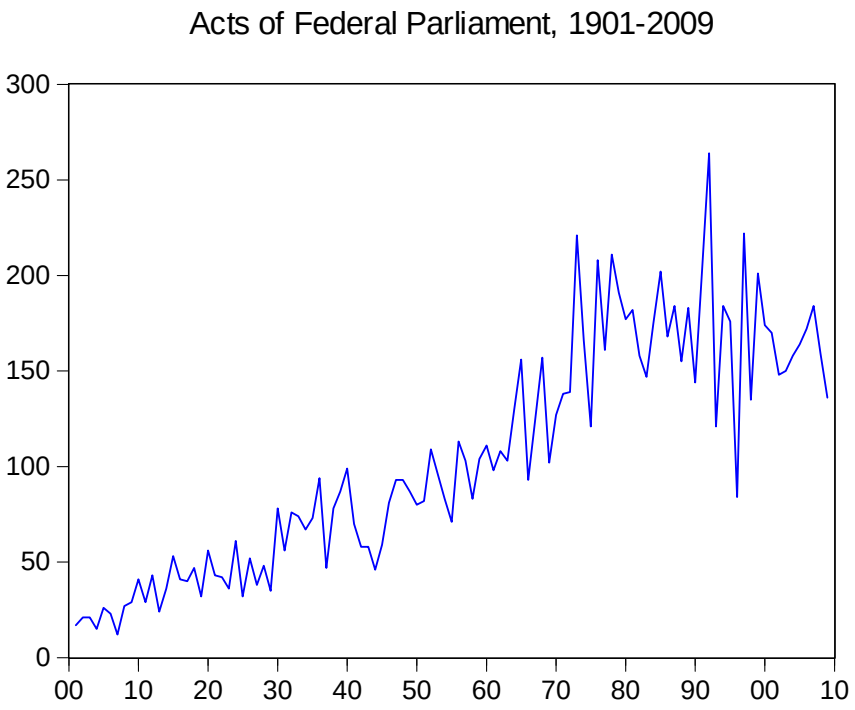
2. The federal political process and legislative output

A brief description of the federal political and legislative process is in order, as the institutions of Australian government have implications for the dynamics of growth in federal legislation (see McAllister *et al* (1997) for an overview of the Australian political system). Australia has a parliamentary system of government and a federal parliament comprised of two houses. The House of Representatives has been elected on the basis of a constituency-based system since 1918. The Senate is elected via a proportional representation voting system within each state and territory. Acts of federal parliament require the support of both houses of parliament and are generally initiated by the governing party or coalition in the House of Representatives. Governments formed in the House of Representatives will often not enjoy a majority in the Senate. The division of power between the House of Representatives and Senate can result in new legislation being blocked or amended by non-government parties. New acts of parliament may represent new legislation or may amend or repeal older legislation. Some 'machinery' legislation, such as the budget appropriation bills, is required at regular intervals, but are small in number compared to the overall legislative output of parliament.

Governments formed in the House of Representatives are elected for a notional term of three years, but enjoy considerable discretion over the timing of the next general election. The

variable timing of federal elections disrupts the sitting schedule of federal parliament, so election years are often characterised by reduced legislative activity relative to non-election years. Figure 1 shows the number of acts passed by federal parliament for each calendar year since 1901.

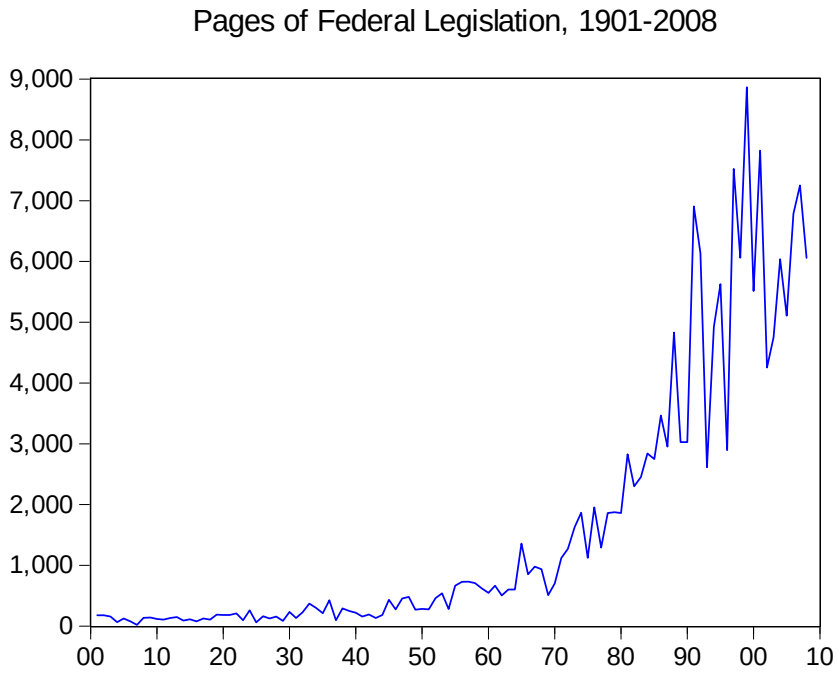
Figure 1



Source: (Parliament of the Commonwealth of Australia 2005, 794)

The chart shows steady growth in legislative activity from 1901 until the early 1970s, before stabilising in a very broad range. The number of pages of legislation has also increased over time, especially since the early 1970s (Figure 2).

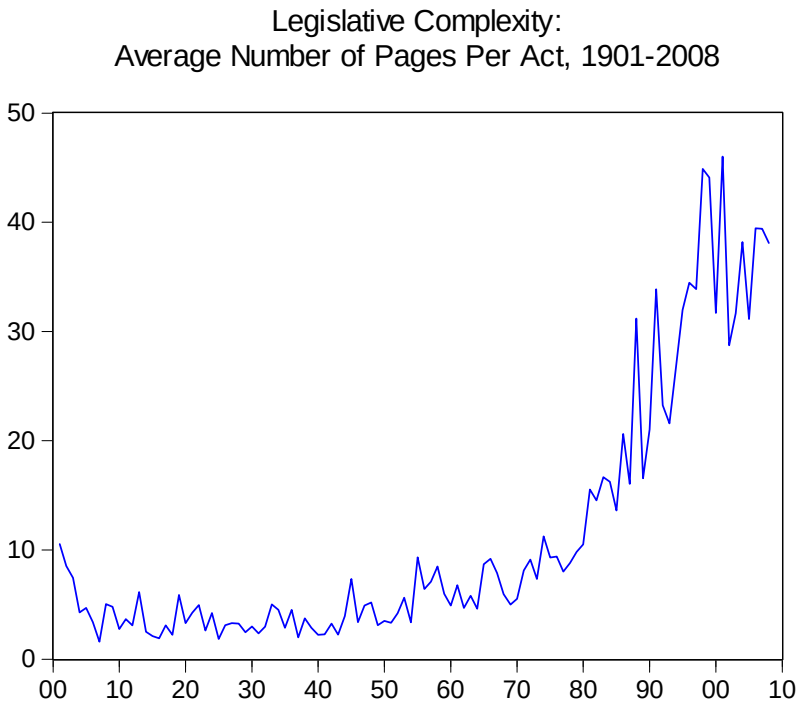
Figure 2



Source: (Berg 2008).

Dividing the number of pages of legislation enacted by the number of individual acts yields a proxy for legislative complexity, shown in Figure 3.

Figure 3



Source: derived from series in Figures 1 and 2.

3. Data and order of integration tests

In addition to the three measures of legislative output shown above, the following explanatory variables are used in subsequent empirical work (see Appendix for data sources and definitions):

ELECTION is a dummy variable that takes a value of one in election years and zero otherwise to account for the disruptive effect of general elections on federal legislative activity.

D^{1907} is a dummy variable that takes a value of 1 in 1907 and zero otherwise. 1907 is an outlier, with a record low 12 acts of parliament passed in that year.

hours is the log of the number of hours the House of Representatives sits in a calendar year. The number of sitting hours varies from year to year for a variety of reasons, including federal elections and so has an influence on the quantity of legislative output.

rgdp is the log of real GDP per capita.

Δ***SOI*** is the June on June change in the Southern Oscillation Index. Positive values of the index are associated with wetter than average conditions, negative values with drier than average conditions, with a historical mean approximately equal to zero. The index captures the effects of rainfall on Australian agricultural output and thus serves as a proxy for exogenous shocks to agricultural output.

WWII is a dummy variable that takes a value of one in the years 1940-1945 to capture the disruptive effect of World War II on legislative activity and the increased reliance on executive rather than parliamentary authority in these years.

It is necessary to test the orders of integration of the dependent and explanatory variables to determine the most appropriate specification for the three proposed empirical models. Table 1 shows ADF tests for the order of integration for the log of new acts of parliament (*acts*), the log of the number of new pages of federal legislation enacted (*pages*) and the log of the number of pages enacted divided by the number of new acts (*complexity*), as well as federal parliamentary sitting hours (*hours*) and real GDP per capita (*rgdp*).

Table 1: Augmented Dickey-Fuller Tests

Variable[(a)]	Lags[(b)]	Constant	Constant & Trend
acts	2/2	-2.025	-2.626
Δ*acts*	1/4	-12.977***	-8.328***
pages	2/1	-0.105	-5.384***
Δ*pages*	1/1	-12.182***	-12.198***
complexity	2/1	-0.172	-3.986**
Δ*complexity*	1/1	-11.136***	-11.383***
rgdp	2/2	0.4761	-1.844
Δ*rgdp*	1/1	-7.162***	-7.201***
hours	3/3	-3.977***	-4.219***
Δ*hours*	1/1	-15.724***	-15.665***

Notes: (a) *t*-tests for ρ=1 in regressions of $y_t = \alpha + \rho y_{t-1} + \varepsilon_t$ and $y_t = \alpha + \beta_t + \rho y_{t-1} + \varepsilon_t$ for sample period 1900-2008 or 2009. ***,**,* denote the 1, 5 and 10 per cent significance levels respectively. (b) Lag length for test with constant/constant and trend, chosen by SIC.

The integration tests find that the data are I(1) in levels, although *pages* and *complexity* are found to be stationary in levels with the inclusion of an exogenous trend, while *hours* is stationary in levels regardless of choice of exogenous regressors. Given uncertainty about whether the data are trend or first-difference stationary, the bounds testing procedure for level relationships suggested by Pesaran, Shin and Smith (2001) can be employed to test the significance of the lagged levels of the variables of interest in a conditional unrestricted error correction framework. This approach allows testing of long-run relationships in a manner that is robust to the order of integration of the variables and the presence of cointegrating relationships. Standard errors for the estimated long-run relationships between variables in

levels can be obtained using Bårdsen's (1989) methodology. The non-standard critical values derived by Ericsson and Mackinnon (2002) can also be compared to the *t*-statistic on the lagged level of real GDP per capita to test for cointegration under the assumption that real GDP per capita is weakly exogenous for the three measures of legislative output.

4. Empirical specification and results

Three models are estimated by least squares using data for the period from 1900 to 2009 and for pre- and post-war sub-samples (1901-1945 and 1946-2009), adjusted for lags in variables and data availability. Equation (1) takes the first-difference in the log of the number of acts passed (***acts***) as the dependent variable. Equation (2) has the first-difference of the log of the number of pages enacted (***pages***) as the dependent variable. Equation (3) takes the first-difference of the log of the average number of pages per act (***complexity***) as the dependent variable.

Equation (1) takes the following form:

$$\Delta acts_t = \alpha_0 + \alpha_1 \Delta acts_{t-1} + \alpha_2 \Delta acts_{t-2} + \alpha_3 \Delta acts_{t-3} + \alpha_4 \Delta hours_t + \alpha_5 ELECTION_t + \alpha_6 D_t^{1907} + \alpha_7 WWII_t + \alpha_8 \Delta rgdp_{t-1} + \alpha_9 \Delta SOI_t + \alpha_{10} rgdp_t + \alpha_{11} acts_t + \varepsilon_t \quad (1)$$

Table 3 shows the full and sub-sample results for equation (1).

Table 3. Equation 1: Growth in Acts of Federal Parliament

Variable	Full Sample	Pre-War	Post-War
Constant	26.120 (49.516)	803.650** (370.059)	79.257 (59.129)
$\Delta acts_{t-1}$	-0.529*** (0.106)	-0.462*** (0.155)	-0.468*** (0.156)
$\Delta acts_{t-2}$	-0.308*** (0.105)	-0.284* (0.161)	-0.320** (0.143)
$\Delta acts_{t-3}$	-0.226*** (0.081)	-0.400*** (0.118)	-0.080 (0.112)
$\Delta hours_t$	0.230*** (0.085)	0.326*** (0.105)	0.089 (0.156)
$ELECTION_t$	-0.171*** (0.051)	-0.165** (0.079)	-0.194*** (0.068)
D^{1907}_t	-0.904*** (0.216)	-1.149*** (0.230)	
$WWII_t$	-0.203** (0.088)	0.062 (0.150)	
$\Delta rgdp_{t-1}$	-1.223* (0.670)	-0.043 (0.847)	-1.900* (1.127)
ΔSOI_t	-0.003** (0.001)	-0.002 (0.002)	-0.004** (0.002)
$rgdp_{t-1}$	0.065 (0.082)	-0.841* (0.450)	0.094 (0.115)
$acts_{t-1}$	-0.156** (0.069)	-0.181* (0.096)	-0.314** (0.151)
$\theta=\alpha_{10}/-\alpha_{11}$	0.413 (0.537)	-4.643 (3.686)	0.299 (5.533)
F-test of $\alpha_{10}+\alpha_{11}=0$	6.051**	5.937**	7.853***
Adj. R^2	0.681	0.745	0.615

S.E	19.96	19.89	18.16
JB-test	{0.13}	{0.54}	{0.61}
LM test			
-1st order	{0.6702}	{0.7532}	{0.5730}
-4th order	{0.1504}	{0.7326}	{0.4663}
BPG-test	{0.5173}	{0.5402}	{0.2181}

Notes: Sample period is 1905-2009. Numbers in parentheses () are standard errors, those in braces {} are *p*-values. ***,**,* denote the 1, 5 and 10 per cent significance levels respectively. *F*-test critical values based on Pesaran *et al* (2001). All variables are multiplied by 100 so coefficients are in percentages.

The lags of the dependent variable shows that growth in the number of acts follows a third-order autoregressive process, which is likely driven by the three-year terms of the federal parliaments in which Australian governments are formed. An increase in the hours federal parliament sits results in an increase in the quantity of legislation passed, although this effect is not statistically significant in the post-World War II period. Federal election years reduce growth in the number of acts passed, consistent with their disruptive effect on the parliamentary schedule and legislative process. World War II had a similarly negative effect, stemming from the disruptive effect of the war and the increased use of executive rather than legislative authority during the war years. The year 1907 is a statistically significant outlier, as previously noted.

The coefficient on lagged growth in real GDP per capita implies that a one percent increase in real income per capita in the previous year yields a 1.2% decrease in the growth rate of acts of federal parliament in the current year, with a slightly larger coefficient in the post-World War II period, but only at the 10% level of statistical significance. If the annual variation in growth in real GDP per capita is mainly driven by the business cycle rather than changes in permanent income, then this result implies that growth in the number of acts passed is driven by temporary economic shocks. The estimated response is consistent with negative economic shocks leading to increased legislative enactments to insulate political constituencies against economic adversity. This is also suggested by the (very small) negative coefficient on the change in the SOI, which captures weather-related shocks to farm output, although this result is also only statistically significant for the post-war period.

The *F*-test for the joint significance of the lagged variables in levels exceeds the upper bound of the five percent critical values suggested by Pesaran *et al*'s (2001) bounds testing procedure for the full and pre-World War II sample period ($F_{Upper} = 4.85$) and the one percent critical values for the post-war sample period ($F_{Upper} = 6.36$). However, the estimated long-run relationship shows considerable parameter instability and the large standard errors on the long-run coefficient ($\theta=\alpha_{10}/-\alpha_{11}$) obtained using Bårdsen's (1989) methodology argues against a robust long-run relationship between acts passed and the level of real GDP per capita. The cointegration test proposed by Ericsson and MacKinnon (2002) for the null of $\alpha_{11} = 0$ is not rejected, with a *p*-value of 0.3040 for the full sample, 0.4427 for the pre-war sample and 0.3247 for the post-war sample using their non-standard critical values (this test

differs from the significance levels reported in the table). There is not a robust long-run relationship between acts passed and the level of real GDP per capita.

Equation (2) models growth in *pages* and is given an error correction specification of the following form:

$$\Delta pages_t = \alpha_0 + \alpha_1 \Delta pages_{t-1} + \alpha_2 ELECTION_t + \alpha_3 D_t^{1907} + \alpha_4 \Delta rgdp_{t-1} + \alpha_5 rgdp_{t-1} + \alpha_6 pages_{t-1} + \varepsilon_t \quad (2)$$

Table 4 shows the full and sub-sample results for equation (2).

Table 4. Equation 2: Growth in Pages of Federal Legislation

Variable	Full Sample	Pre-War	Post-War
Constant	-779.037***	-159.328	-1018.335***
	(213.466)	(404.990)	(208.99)
$\Delta pages_{t-1}$	-0.322***	-0.321**	-0.1630*
	(0.082)	(0.123)	(0.083)
$ELECTION_t$	-0.2504***	-0.285**	-0.219**
	(0.080)	(0.136)	(0.084)
D_t^{1907}	-1.758***	-1.912***	
	(0.097)	(0.170)	
$\Delta rgdp_{t-1}$	-2.815**	-2.262	-2.504
	(1.278)	(1.807)	(1.761)
$rgdp_{t-1}$	1.211***	0.535	1.596***
	(0.317)	(0.502)	(0.308)
$pages_{t-1}$	-0.472***	-0.558***	-0.642***
	(0.121)	(0.171)	(0.118)
$\theta=\alpha_5/-\alpha_6$	2.569***	0.958	2.489***
	(0.152)	(0.825)	(0.149)
F-test of $\alpha_5+\alpha_6=0$	13.549***	0.003	22.401***
Adj. R^2	0.568	0.622	0.459
S.E	35.711	43.490	29.545
JB-test	{0.77}	{0.84}	{0.53}
LM test			
-1st order	{0.28}	{0.42}	{0.74}
-4th order	{0.30}	{0.21}	{0.76}
BPG-test	{0.01}	{0.08}	{0.77}

Notes: Sample period is 1903-2009. Numbers in parentheses () are Newey-West HAC robust standard errors, those in braces {} are *p*-values. ***,**,* denote the 1, 5 and 10 per cent significance levels respectively. *F*-test critical values based on Pesaran *et al* (2001). All variables are multiplied by 100 so coefficients are in percentages.

Since the error variance for equation (2) shows signs of heteroskedasticity, robust standard errors are reported. Lagged growth in real GDP per capita has a large effect on growth in the number of pages of legislation enacted, with an estimated elasticity of -2.8%. This is consistent with the previous model in suggesting that legislative output responds to economic shocks. In particular, there is an increase in legislative output in response to economic downturns that likely reflects an attempt to insulate political constituencies against adverse shocks. The magnitude is similar across sub-samples, although falls short of conventional levels of statistical significance in the sub-sample estimates.

The *F*-test for the joint significance of the variables in levels exceeds the upper bound for the one per cent critical values derived by Pesaran *et al* (2001), although only for the post-World War II period. The long-run elasticity of growth in pages enacted with respect to the level of real GDP per capita is given by $\theta=\alpha_5/-\alpha_6$, for which the reported standard errors are obtained using Bårdsen's (1989) methodology. The full-sample long-run elasticity is 2.6, although this result is driven by the post-World War II sample. The pre-war sample does not yield statistically significant results. The positive long-run relationship between the level of real GDP per capita and the growth in pages enacted is consistent with Wagner's law in suggesting that legislative output is positively related to economic development, as measured by the level of real GDP per capita, with an elasticity greater than one. The cointegration test proposed by Ericsson and MacKinnon (2002) for the null of $\alpha_6 = 0$ is rejected, with a *p*-value of 0.0094 for the full sample, 0.0563 for the pre-war sample and 0.0000 for the post-war sample using their non-standard critical values (this test differs from the significance levels reported in the table). This points to a long-run relationship with the level of real GDP per capita, although again, only for the post-war period.

Equation (3) models growth in *complexity* and is given an error correction specification of the following form:

$$\Delta complexity_t = \alpha_0 + \alpha_1 \Delta complexity_{t-1} + \alpha_2 D_t^{1907} + \alpha_3 \Delta rgdp_{t-1} + \alpha_4 rgdp_{t-1} + \alpha_5 complexity_{t-1} + \varepsilon_t \quad (3)$$

The results are shown in Table 5, for which robust standard errors are reported.

Table 4. Equation 3: Growth in Complexity of Federal Legislation

Variable	Full Sample	Pre-War	Post-War
Constant	-481.95***	376.999	-597.721***
	(89.64)	(787.66)	(195.278)
$\Delta complexity_{t-1}$	-0.469***	-0.084	-0.468***
	(0.076)	(0.193)	(0.083)
$\Delta complexity_{t-2}$	-0.182**	-0.012	-0.198*
	(0.084)	(0.130)	(0.108)
D_t^{1907}	-0.733***	-0.833***	
	(0.072)	(0.156)	
$\Delta rgdp_{t-1}$	-1.093	0.665	-1.173
	(1.025)	(2.645)	(1.494)
$rgdp_{t-1}$	0.612***	-0.306	0.7334***
	(0.110)	(0.886)	(0.235)
$complexity_{t-1}$	-0.360***	-0.969***	-0.363***
	(0.063)	(0.316)	(0.118)
$\theta=\alpha_4/-\alpha_5$	1.700***	-0.316	2.023***
	(0.150)	(0.822)	(0.314)
F-test of $\alpha_4+\alpha_5=0$	15.588***	1.165	7.788***
Adj. R^2	0.431	0.4902	0.402
S.E	30.568	36.076	25.233
JB-test	{0.24}	{0.33}	{0.36}
LM test			
-1st order	{0.11}	{0.49}	{0.07}
-4th order	{0.08}	{0.28}	{0.33}
BPG-test	{0.10}	{0.10}	{0.26}

Notes: Sample period is 1905-2008. Numbers in parentheses () are Newey-West HAC robust standard errors, those in braces {} are *p*-values. ***,**,* denote the 1, 5 and 10 per cent significance levels respectively. *F*-test critical values based on Pesaran *et al* (2001). All variables are multiplied by 100 so coefficients are in percentages.

The model for legislative complexity does not show a statistically significant short-run relationship with lagged growth in real GDP per capita, although the sign and magnitude of the coefficient is not inconsistent with that found for the other two measures of legislative output. The complexity proxy is designed to capture a qualitative rather than a quantitative dimension to legislative output and is more likely to respond to long-run economic development, as proxied by the level of real GDP per capita, than short-run shocks to growth in GDP per capita. The *F*-test for the joint significance of the lagged variables in levels exceeds the upper bound for the one per cent critical values derived by Pesaran *et al* (2001), for the full sample and the post-World War II period, but not the pre-war period. The long-run relationship between legislative complexity and the level of real GDP per capita given by $\theta = \alpha_4/-\alpha_5$ has an estimated elasticity of 1.7% for the full sample period. Again, this result is driven by the post-World War II sample period, for which the elasticity is 2%. The pre-war sample period does not yield statistically significant results. The cointegration test proposed by Ericsson and MacKinnon (2002) for the null of $\alpha_5 = 0$ is rejected, with a *p*-value of 0.0000 for the full sample, 0.0810 for the pre-war sample and 0.0773 for the post-war sample using their non-standard critical values (this test differs from the significance levels reported in Table 4). This points to a long-run relationship between complexity and the level of real GDP per capita, although the *p*-values for the sub-samples exceed the 5% significance level.

5. Conclusion

The results from the three models estimated in this paper imply that legislative output responds to short-run economic shocks, with the political process responding to negative economic shocks with increased legislative activism in terms of both acts and the number of pages of legislation passed, but without a statistically significant effect on legislative complexity. Given that growth in real GDP per capita is positive on average, it is difficult to account for the long-run growth in federal legislative output with reference to these short-run dynamics. The empirical results suggest that there is a positive long-run relationship between legislative output, as measured by the number of pages enacted and legislative complexity and the level of real GDP per capita. This long-run relationship is consistent with Wagner's law of increasing state activity, which suggests that growth in government is driven by long-run trends in economic development that are captured by the level of real GDP per capita. While some contributions to the literature on Wagner's law have found that this long-run relationship is driven by interactions between income and the age dependency ratio (Shelton 2007), no role could be found for an Australian age dependency ratio variable in the empirical models developed in this paper.

The lack of statistical support for either the short or the long-run relationship in the pre-World War II sample places a question mark over the general applicability of these results and Wagner's law. This finding is consistent with the increased government activism observed throughout the developed world in the post-war period, but may also indicate that there is no necessary long-run historical relationship between these proxies for government growth and national income. This is consistent with the results obtained by Durevall and

Henrekson (2010) for Britain and Sweden, where Wagner's law holds for specific periods in the two countries' history, but not for others. The time frame and stage of economic development over which Wagner's law is meant to apply has not been settled by previous theoretical or empirical work. It could be that Wagner's law must attain a threshold condition for government size or scope that was not satisfied in Australia's case until after World War II. Further research could test this proposition in a cross-country setting using a similar approach to the one taken here.

Data Appendix

Data definitions and sources are as follows:

acts is the log of the number of acts passed by the Australian federal parliament in a calendar year. Source: *House of Representatives Practice*, 5th edition, Parliament of the Commonwealth of Australia, 2005, Appendix 17. Online version updated with data to 2009.

ELECTION is a dummy variable that takes a value of one in calendar years that include federal elections and zero otherwise. Sources: McAllister *et al* (1997) and Barber *et al* (2008)

hours is the log of the number of hours the House of Representatives sits in a calendar year. Source: *House of Representatives Practice*, 5th edition, Parliament of the Commonwealth of Australia, 2005, Appendix 16. Online version updated with data to 2009.

pages is the log of the number of pages of federal legislation enacted annually. Source: Berg (2008).

rgdp is the log of Australian real GDP per capita, 1990 Geary-Khamis PPP dollars. Source: Angus Maddison, Statistics on World Population, GDP and Per Capita GDP, 1-2008 AD, http://www.ggdc.net/maddison/.

Δ***SOI*** (Southern Oscillation Index, is the June on June change in the standardised anomaly of the Mean Sea Level Pressure (MSLP) difference between Tahiti and Darwin, calculated as SOI = 10*[(Pdiff – Pdiffav)/SD(Pdiff)] where Pdiff = (average Tahiti MSLP for the month) - (average Darwin MSLP for the month), Pdiffav = long term average of Pdiff for the month in question, and SD(Pdiff) = long-term standard deviation of Pdiff for the month in question. Source: Australian Bureau of Meterology http://www.bom.gov.au/climate/glossary/soi.shtml, which includes a discussion of the effects of the SOI on Australian weather patterns.

WWII is a dummy variable that takes a value of one in the years 1940 to 1945.

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