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Division of Labor, Specialization and
the Enforcement of a System of
Property Rights:
A General Equilibrium Analysis
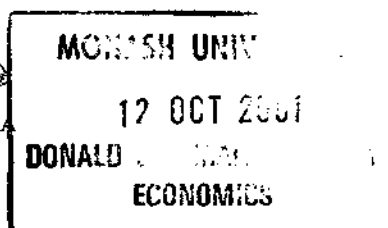
Li Ke and Russell Smyth

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MONASH UNIVERSITY

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Property Rights: A General Equilibrium Analysis

Li Ke[*] and Russell Smyth[† ‡]

Abstract

This paper uses a model of endogenous theft and endogenous network division of labour to formalise some of the main principles of the economics of the state and to explore related issues why new constitutional rules emerge and evolve. First, we develop a two good consumer-producer model with endogenous specialization and endogenous stealing. Following this we introduce a Sovereign's decision to collect tax and to allocate tax revenue between her consumption and enforcement of property rights into the model. Finally, we use this framework to examine trade-offs between the positive effects of third party property rights protection, and the negative effects of taxation, on the division of labour. We illustrate our results using the growth of the states' system in Western Europe.

1. Introduction

Early economic analysis of the enforcement of property rights can be traced back to classical writers such as Montesquieu, Beccaria, Bentham, Hobbes and Rosseau. Hobbes and Rosseau, in particular, examined human society in its primordial "state of nature" where there is no third party protection of property rights. Hobbes argued that in the primordial state of nature, the "law of the jungle" prevailed in which individuals allocate part of their endowments to self-protecting their own goods and stealing goods from other parties. Hobbes advocated that the "laws of nature" dictated the establishment of a property rights system with third-party protection, which he called the "Commonwealth", which mandated punishment for those who violate the rights of others.

Hobbes described this as follows:

> .... there must be some coercive power to compell men ... by the terrour of some punishment greater than the benefit they expect by the breach of their Covenant; and to make good that Proprietry, which by mutuall Contract men acquire, in recompence of the Universall Right they abandon: and such power there is none before the erection of a Commonwealth (Hobbes 1651 [1973], pp. 71-72).

Rousseau recognized that while establishing social order consists of a reduction in liberty there are also several benefits compared to the state of nature, including a reduction in the resources devoted to socially unproductive activities such as stealing and self-protection, less the costs of enforcement. He described the trade-off in the following terms:

> What a man loses as the result of the Social Contract is his natural liberty and his unqualified right to lay hands on all that tempts him, provided only that he can encompass its possession. What he gains is civil liberty and the ownership of what belongs to him (Rousseau 1762 [1948], Chapter VIII).

Hobbes and Rouseau do not explain how the Commonwealth endogenously evolves from the primordial state of nature. The work of these early writers, however, has formed the basis for more recent studies of distributional conflicts in preconstitutional states and the emergence of social contracts. Bush and Mayer (1974) present a formal model of distributional conflicts in a preconstitutional state. Several modern commentators including Buchanan, Barzel, Olson and Umbeck examine various aspects of the emergence of a social constitution in non-mathematical terms. Buchanan (1975, 1991) analyzes the basis for a society where people want to be free but recognize

the inherent limits that social interdependence places on them. Barzel (1998a, 1998b) and Umbeck (1981) use contract theory to analyze property rights and the evolution of the state. Olson (1993) explores the circumstances when an autocrat will emerge from Hobbes' state of nature and examines the effect of an autocrat on productivity. Meanwhile Skogh and Stuart (1982) go one step further and develop a formal model of the emergence of enforced property rights via a social contract. There is also wide agreement among modern commentators on the essential features of a social contract. The social contract should have the following components: rules to establish property rights, a mechanism for enforcing sanctions for violations of property rights and rules which specify a taxation system, through which each individual contributes to the maintenance of the property rights system or "criminal justice system" (Skogh and Stuart 1982, pp. 28-29).

This paper is similar to that of Skogh and Stuart in that we also develop a formal model of the emergence of enforced property rights. Skogh and Stuart, however, do not consider the effect of improved sanctions on specialization and the division of labour. In this paper we develop a formal model that examines this issue. This is consistent with the contention of several classical writers that specialization and the division of labour are the main factors driving economic growth and welfare. Yang and Ng (1998, p.

3) go so far as to suggest that specialization and the division of labour lie at the core of classical economics. This is perhaps clearest in the writings of Josiah Tucker (1774) who referred directly to the productivity implications of the division of labour and Adam Smith (1776 [1976], Book 1, Chapter 3) who, amongst other things, was the first to conjecture that the division of labour is limited by the extent of the market.

Yang and Ng (1993) formalize the classical perspective of economic development through taking into account transaction costs. They utilize a consumer-producer approach to show that an exogenous improvement in transaction conditions leads to enhanced levels of individual specialization, increased degrees of roundaboutness of production, and an increased variety of intermediate goods. However, Yang and Ng do not endogenize stealing and the enforcement of property rights by the government in their model. This paper extends Yang and Ng's model to examine the effect of stealing and third party protection of property rights on the network size of the division of labour.

In the first part of the model, we show how the state can endogenously emerge from taxation that is used to finance the judicial system and

enforcement of laws that penalize theft. The trade-off between the positive network effects of the criminal law and their enforcement and the negative effects of taxation on the network size of division of labour can be used to predict in which parameter subspace this occurs. In the second part of the model, a Sovereign is specified as the monopolist of legitimate violence, setting up a trade-off between her direct consumption from tax revenue and her indirect consumption via more effective enforcement of criminal laws. Here, we adopt Barzel's (1998b) use of the term violence. He defines violence as the "means of enforcing costs by individuals who do not form relations with others" (Barzel 1998b, p.4). In the third part of the model, competition between two kingdoms, with free migration between the kingdoms, is specified as a determinant of the equilibrium allocation of tax revenues between the sovereigns' consumption, the optimal level of law enforcement and level of taxation.

Through examining the inter-relationship between the division of labour, protection of property rights, specialization and stealing, the model formalizes some central observations of constitutional economics and the economics of the state. The model, which we develop, suggests there are important circular effects, which are propelling improvements in economic growth and welfare.

In particular, improvements in institutional efficiency expand the demand for transactions, which in turn increases the need for further third party protection of property rights. The division of labour is determined by the enforcement of property rights which itself is dependent on the level of taxation revenue, while the amount of taxation revenue is dependent on productivity and the division of labour.

The paper is set out as follows. In section two we develop a general equilibrium consumer-producer model with two final goods, stealing and taxation. In section three we examine the optimal allocation of resources and per capita income in two alternative market structures; namely, autarky and the complete division of labour with stealing. We then introduce a Sovereign who provides third party protection of property rights in the market structure with division of labour and stealing and solve the model through endogenizing the Sovereign's optimal personal consumption and taxation rate. In section four we assume there are two countries; initially we consider the case where one country has a Sovereign who provides third party protection of property rights, while the other one is still in Hobbes' primordial state of nature. We then proceed to examine the case where both countries have sovereigns, but their personal consumption of the tax rate

differs. We use the rise of modem capitalism in Western Europe to illustrate our findings.

2. The Basic Model

Consider a large economy with M ex ante identical consumer-producers and two final consumer goods x and y, where the set of individuals is assumed to be a continuum.

Assumption 1

Each individual can only steal goods from parties with whom she trades.

We make the following further assumptions. First, each individual cannot steal goods which have already been traded in the market. This implies that property rights to goods traded in the market are well enforced. Second, all individuals are *ex ante* identical and only differ after they choose to specialize in the production of x and/or y. Third, the whole economy is symmetrical. This assumption can be relaxed, but makes the calculations more onerous. We further assume that x and y can either be self-produced or purchased from the market. The self-provided consumption of good x is denoted as x^r, the amount sold in the market is x^s, and the amount purchased from the market is x^d. The transaction efficiency coefficient is k for each unit of x and y

purchased from the market and kx^d is the consumption of that part of good x purchased in the market, where $k \in (0,1)$.

We assume that the level of self-protection which other parties have is exogenously given. Thus people can steal other parties' property if they spend effort on this kind of activity. We use x^i and y^i to denote the total amount of labour that an individual expends on stealing x and y owned by other parties. We use t to denote the stealing efficiency coefficient without third party protection and we assume $t \in (0,1)$, while we use T to denote the stealing efficiency coefficient with third party protection of property rights by the Sovereign. The relationship between t and T will be

$$(2.1) \qquad T = \frac{t}{(1+s)^{\frac{1}{2}} \cdot [1 + (1-\beta)]^{\frac{1}{2}}}$$

Here, the parameter s is the taxation rate imposed by the Sovereign. The parameter β is that fraction of the total taxation revenue personally consumed by the Sovereign and $1-\beta$ is the percentage of the total taxation revenue that the Sovereign devotes to the protection of property rights. The stealing efficiency coefficient, t, represents the other parties self-protection which, as noted above, is exogenously given. In addition, we assume $s \in (0,1)$ and

$\beta \in (0,1)$, as well as $\beta = 1$ when $s \to 0$. From the stealing function, it is easy to show that when the taxation rate s and $1 - \beta$ increases, the stealing efficiency coefficient with third party protection of property rights, T, will be less than the stealing efficiency coefficient without third party protection of property rights, t.

Strictly speaking, the parameter t represents the relative efficiency of an individual's stealing activities compared to others self-protection activities. Thus, $t \cdot x^t$ is the consumption of good x from stealing and $t \cdot y^t$ is the consumption of good y from stealing. Similarly, the parameter T represents the relative efficiency of an individual's stealing activities compared to others self-protection activities with third party protection of property rights. Thus, taking third party protection into account, $T \cdot x^t$ is the consumption of good x from stealing and $T \cdot y^t$ is the consumption of good y from stealing. In addition, because each person is assumed to be *ex ante* identical and other parties will also attempt to steal the individual's goods, we use x^r and y^r to denote quantities of x and y which other parties steal from the individual.

Each consumer-producer has identical, non-satiated, continuous, and rational preferences, which are represented by the following utility function:

$$(2.2) \qquad u = f(x^c, y^c)$$

Here $x^c \equiv (x^r + k \cdot x^d + T \cdot x')$ and $y^c \equiv (y^r + k \cdot y^d + T \cdot y')$ are the amounts of the two goods that are consumed. $f(.)$ is continuously increasing and quasi-concave.[1] For simplicity, we assume that $f(.) = (x^c) \cdot (y^c)$.

The individual's production function, which has fixed learning costs, can be depicted as:

$$(2.3) \qquad x^p = \max\{l_x - \alpha, 0\} \qquad \alpha \in (0,1),$$

$$y^p = \max\{l_y - \alpha, 0\} \qquad \alpha \in (0,1).$$

Here, x^p and y^p represent the individual's total output of good x and good y respectively. The term l_x represents the amount of time used to produce good x and, thus, the individual's level of specialization in producing good x. The term l_y has a similar meaning for good y. The parameter α is a fixed learning cost and is positively related to the degree of economies of specialization in good x and good y respectively.

The total amount left after the sale of each good is:

$$(2.4) \qquad x = \max\{x^p - x^s, 0\},$$

$$y = \max\{y^p - y^s, 0\},$$

where x^s and y^s are the amounts of good x and good y that are sold in the market.

The consumption of good x and y, which is self-provided is:

(2.5) $$x^r = \max\{x - x^T, 0\},$$

$$y^r = \max\{y - y^T, 0\}.$$

Here, x^r and y^r are the amounts of the two goods that are stolen from the individual by others. The individual treats x^r and y^r as given when she chooses her own stealing activity level. In this sense, stealing activities among all of the individuals in this model resembles a Nash game, while individuals choose the quantities of production, trade, and consumption for given market prices according to a Walrasian regime.

The individual's stealing functions are as follows:

(2.6) $$x^t = l_{tx}^\theta,$$

$$y^t = l_{ty}^\theta,$$

where x^t and y^t are the total amounts of good x and y which the individual steals from the other parties. It is assumed that $\theta \in (0,1)$, which means

stealing activities exhibit decreasing returns to scale. For the purpose of simplicity, and without losing generality, we let $\theta = \dfrac{1}{2}$ from now on.

The budget constraint for the individual is:

(2.7) $p_x x^s + p_y y^s = (1+s) \cdot p_x x^d + (1+s) \cdot p_y y^d$.

The parameter s is the taxation rate imposed by the Sovereign. The budget constraint implies that the Sovereign can collect tax revenue only when there are market transactions. Moreover, the model also implies that endogenous institutional factors exist that determine the labour cost of establishing market transactions. A high value of T denotes an inefficient institutional system, which encourages individuals to steal goods from others. This is because when T is high, each individual incurs high costs in order to protect her property rights. Furthermore, all the variables, parameters and coefficients are non-negative.

3. Alternative Configurations and Structures

Yang and Ng (1993) establish Lemma 1 in a multilateral bargaining game.

Lemma 1

According to the Kuhn-Tucker condition, the optimal configuration will be where each person sells at most one good and does not purchase or self-provide the same good.

Lemma 1 and assumption 1, above, imply that theft never occurs in autarky and that an individual specializing in producing good x cannot steal from another individual specializing in producing good x. This is because individuals specializing in producing good x will only trade with individuals specializing in producing good y.

Taking into account Lemma 1 and assumption 1, we first consider two alternative configurations; namely, autarky, which we will call structure A, and the complete division of labour with stealing, which we will call structure D^S. There is a Sovereign who provides third party protection of property rights in the D^S structure.

A. Autarky (Structure A)

In autarky every individual chooses the configuration A, which implies $x^s = x^d = y^s = y^d = x^t = x^T = y^t = y^T = 0$ for all consumer-producers. Each person in this structure self-provides the two final goods and there are no market transactions. The decision problem for an individual in configuration A can be specified as follows:

(3.1) Max: $u = x \cdot y$

subject to the following constraints,

(3.2) $\quad\quad\quad\quad x^p = x = \max\{l_x - \alpha, 0\}$, $\quad\quad\quad \alpha \in (0,1)$,

$\quad\quad\quad\quad\quad\quad y^p = y = \max\{l_y - \alpha, 0\}$, $\quad\quad\quad \alpha \in (0,1)$,

$\quad\quad\quad\quad\quad\quad l_x + l_y = 1$,

$\quad\quad\quad\quad\quad\quad 0 \le l_x, l_y \le 1$.

The optimal resource allocation in autarky is as follows:

(3.3) $\quad\quad\quad l_x = l_y = \dfrac{1}{2}$,

(3.4) $\quad\quad\quad u(A) = \left(\dfrac{1}{2} - \alpha\right)^2$.

Here, the individual's maximum utility $u(A)$ equals the maximum per capita output level of the two final goods. As each individual only has one unit of labour, $u(A)$ is the real per capita income and the maximum average labour productivity of the final goods.

B. The Complete Division of Labor with Stealing (Structure D^S)

In this structure, all individuals specialize in producing one of the two final goods. Based on Lemma 1, there are two configurations $(xx^T / y^d y^t)$, and $(yy^T / x^d x^t)$ involved in the complete division of labour with stealing, which characterize two alternative choices facing the individual; one option is to

specialize in producing good x and the other option is to specialize in producing good y. We define the symbols in parenthesis taking $\left(xx^T / y^d y^t\right)$ as an example. In this configuration, which is for an individual specializing in good x, x means that the individual self-provides and sells good x; x^T represents the amount of good x which is stolen by others; y^d indicates that the individual buys good y in the market and y^t denote that the individual steals y from others. This configuration can be defined as $x^d = x^t = y = y^t = y^T = 0$, and $x, x^t, x^T, y^d, y^t > 0$.

The decision problem of the individual who specializes in good x is:

(3.5)   Max: $u_{\left(xx^T / y^d y^t\right)} = \left(x - x^T\right) \cdot \left(k \cdot y^d + T \cdot y^t\right)$.

The constraints facing an individual who specializes in good x are:

(3.6) $x + x^t = \max\{l_x - \alpha, 0 \quad\quad \alpha \in (0,1)$,

$y^t = l_{ty}^{\frac{1}{2}}$,

$x - x^T = \max\{l_x - \alpha - x^T, 0 \quad\quad \alpha \in (0,1)$,

$l_x + l_{ty} = 1$,

$T = \dfrac{1}{(1+s)^{\frac{1}{2}} \cdot [1 + (1-\beta)]^{\frac{1}{2}}}$,

$p_x x^t = (1+s)p_y y^d$.

The optimal solution for the individual in configuration $\left(xx^r / y^d y^r\right)$ is:

$$(3.7) \qquad l_{yy} = \frac{t^2 \cdot (1+s)}{4k^2 \cdot p_{xy}^2 \cdot (2-\beta)},$$

$$x^s = \frac{\left(1-\alpha-x^r\right)}{2} - \frac{3t^2}{8k^2 \cdot p_{xy}^2 \cdot (2-\beta) \cdot (1+s)}.$$

Taking symmetry into account, which means $x^r = y^s$, we get

$$(3.8) \qquad x^s = \frac{(1-\alpha)}{2} - \frac{\left[2kp_{xy} \cdot t \cdot (1+s)^{\frac{1}{2}} \cdot (2-\beta)^{\frac{1}{2}} + 3t^2 \cdot (1+s)\right]}{8k^2 \cdot p_{xy}^2 \cdot (2-\beta)},$$

$$(3.9) \qquad u_{\left(xx^r / y^d y^r\right)} = \frac{\{4k^2 \cdot p_{xy}^2 \cdot (1-\alpha) - t \cdot (1+s)^{\frac{1}{2}} \cdot [2kp_{xy} \cdot (2-\beta)^{\frac{1}{2}} - t(1+s)^{\frac{1}{2}}]\}^2}{64k^3 \cdot p_{xy}^3 \cdot (1+s) \cdot (2-\beta)^2}.$$

The optimal solution for configuration $\left(yy^r / x^d x^r\right)$ is symmetric to that for configuration $\left(xx^r / y^d y^r\right)$.

By the utility equalization condition and market clearing conditions, we can obtain the relative prices and the number of individuals of the two different configurations in structure D^s as,

$$(3.10) \qquad \frac{p_x}{p_y} = 1, \text{ and}$$

$$M_{\left(xx^r / y^d y^r\right)} = M_{\left(yy^r / x^d x^r\right)} = \frac{M}{2}.$$

Here $M_{\left(xx^r / y^d y^r\right)}, M_{\left(yy^r / x^d x^r\right)}$ denotes the number of individuals in each respective configuration. The per capita real income in this structure is:

$$(3.11)\ u_{DS} = \frac{\{4k^2 \cdot (1-\alpha) - t \cdot (1+s)^{\frac{1}{2}} \cdot [2k \cdot (2-\beta)^{\frac{1}{2}} - t(1+s)^{\frac{1}{2}}]\}^2}{64k^3 \cdot (1+s) \cdot (2-\beta)^2}.$$

Because the endowment constraint of this configuration requires $0 \le l_x, l_y \le 1$,

a feasible corner equilibrium in D^S requires $t \le \frac{2k \cdot \sqrt{2-\beta}}{\sqrt{1+s}}$, otherwise $l_y \ge 1$,

which is infeasible. Moreover, since x^s is non-negative, the following

conditions must hold:

$$(3.12) \qquad t \le \frac{k \cdot (1+s)^{\frac{1}{2}} \cdot (2-\beta)^{\frac{1}{2}} \cdot (-1 - \sqrt{13 - 12\alpha})}{3 \cdot (1+s)} < 0, \text{ or}$$

$$t \ge \frac{k \cdot (1+s)^{\frac{1}{2}} \cdot (2-\beta)^{\frac{1}{2}} \cdot (-1 + \sqrt{13 - 12\alpha})}{3 \cdot (1+s)}.$$

Combining the above conditions, we have the following inequality for a

feasible corner equilibrium in D^S:

$$(3.13) \qquad \frac{k \cdot (1+s)^{\frac{1}{2}} \cdot (2-\beta)^{\frac{1}{2}} \cdot (-1 + \sqrt{13 - 12\alpha})}{3 \cdot (1+s)} \le t \le \frac{2k \cdot (2-\beta)^{\frac{1}{2}}}{(1+s)^{\frac{1}{2}}}.$$

We now consider the decision problem of the Sovereign in structure D^S, who

imposes taxation and offers third party protection of property rights. We

assume that when the Sovereign imposes taxation, she faces a trade-off in

terms of what to do with the revenue. The trade-off is between using the

revenue for her own personal consumption and using the revenue to finance

protection of property rights, which in turn will increase future tax revenue through more effective enforcement of criminal laws. Hence, the decision problem of the Sovereign is:

(3.14)   Max: $u_K = x_k^d \cdot y_k^d$

Subject to the budget constraint,

$$（3.15） \qquad p_x x_k^d + p_y y_k^d = s \cdot \beta \cdot (p_x x^d + p_y y^d) \cdot \frac{M}{2}.$$

Here $s \cdot p_x \cdot x^d$ is the tax revenue collected from a good y specialist and the number of good y specialists is $\frac{M}{2}$ in equilibrium. Similarly, $s \cdot p_y \cdot y^d$ is the tax revenue collected from a good x specialist and the number of good x specialists is also $\frac{M}{2}$ in equilibrium.

Inserting the budget constraint into the Sovereign's utility function and replacing $p_{xy} = 1$ and $x^d = y^d = \dfrac{(1-\alpha)}{2(1+s)} - \dfrac{\left[2kp_{xy} \cdot t \cdot (2-\beta)^{\frac{1}{2}} + 3t^2 \cdot (1+s)^{\frac{1}{2}} \right]}{8k^2 \cdot p_{xy}^2 \cdot (2-\beta) \cdot (1+s)^{\frac{1}{2}}}$ in the Sovereign's utility function, the first order conditions of the Sovereign's decision problem will be,

$$(3.16) \qquad \frac{\partial u_K}{\partial \beta} = 0 \qquad \text{and} \qquad \frac{\partial u_K}{\partial s} = 0.$$

This yields the following relationship between the taxation rate and the Sovereign's personal consumption rate:

$$(3.17) \qquad s = \frac{\beta}{2 - \beta}.$$

The optimal value of the variable β is then solved from the following equation,

$$(3.18) \qquad 4k^2(1-\alpha)(2-\beta)^3 - 2^{\frac{1}{2}}kt \cdot (2-\beta)(4-\beta) - 12t^2 = 0.$$

The optimal values of the Sovereign's personal consumption rate and the taxation rate are:

$$(3.19) \qquad \beta^* \approx 2 - \frac{0.8t}{k \cdot (1-\alpha)}, \text{ and}$$

$$(3.20) \qquad s^* \approx \frac{2k(1-\alpha)}{0.8t} - 1.$$

From the above two equations, the optimal utility function of the Sovereign and the individual in structure D^S will become,

$$(3.21) \quad u_K = \frac{M^2 \cdot [2k(1-\alpha) - 0.8t]^4 \cdot [3.2kt - 2\sqrt{2} \cdot kt - 3.8\sqrt{2} \cdot kt(1-\alpha)]^2}{3.2^4 \cdot k^4 \cdot t^4},$$

$$(3.22) \quad u_{DS} = \frac{[1.6\sqrt{2}k(1-\alpha)^{\frac{1}{2}} - 1.6t + \sqrt{2} \cdot t \cdot (1-\alpha)^{\frac{1}{2}}]^2}{51.2 \cdot t \cdot k^4}.$$

Because we assume that the population size, M, is large, the Sovereign's utility will always be higher than her subjects in this economy, given the inequality in (3.13).

(3.23) $\quad - u_K \gg u_{DS}$

4. General Equilibrium and Comparative Statics

A comparison between u_{DS} in (3.22) and u_A in (3.4), yields $u_{DS} > u_A$ if $t^* < t$, where t^* is,

(4.1) $\quad t^* \approx \dfrac{\sqrt{32k \cdot (1-\alpha) \cdot (1+5\alpha) + (1-2\alpha) \cdot k^4} + (1-2\alpha)k^2}{2 \cdot (1+5\alpha)}.$

We now assume there are two countries; namely Country A and Country B. First, we consider the case where one country has a Sovereign which protects property rights, while the other one is still in Hobbes' primordial state of nature. Explicitly, we assume there is a Sovereign in Country A, who provides third party protection of property rights, while in Country B there is no third party enforcement of property rights which implies $s = 0$ and $\beta = 1$ in the basic model according to the previous assumptions. Both countries have the same real per capita income in the autarky structure, but their per capita

income will differ in the D^S structure with complete division of labour and stealing.

$$(4.2) \qquad u_{DSA} = \frac{[1.6\sqrt{2}k(1-\alpha)^{\frac{1}{2}} - 1.6t + \sqrt{2}\cdot t \cdot (1-\alpha)^{\frac{1}{2}}]^2}{51.2 \cdot t \cdot k^4} , \quad \text{and}$$

$$u_{DSB} = \frac{\left[4k^2\cdot(1-\alpha) - t\cdot(2k-t)\right]^2}{64\,k^3}.$$

Comparing u_{DSA} and u_{DSB} with u_A respectively, $u_{DSB} > u_A$, if the following inequality holds:

$$(4.3) \qquad t > t_0 \equiv k + \sqrt{k^2 + 4k^{\frac{3}{2}}\cdot[(1-2\alpha) - k^{\frac{1}{2}}\cdot(1-\alpha)]} .$$

Similarly $u_{DSA} > u_A$, if the following inequality holds:

$$(4.4) \qquad t > t^* \approx \frac{\sqrt{32k\cdot(1-\alpha)\cdot(1+5\alpha) + (1-2\alpha)\cdot k^4} + (1-2\alpha)k^2}{2\cdot(1+5\alpha)} .$$

Here, both t_0 and t^* are within the domain for a feasible corner equilibrium in structure D^S. It is easy to show that if $k > k_0 \equiv (\frac{1-2\alpha}{1-\alpha})^2$, the relationship between t_0 and t^* is,

$$(4.5) \qquad t^* < t_0$$

This relationship indicates that the emergence of a Sovereign, who offers third party protection of property rights will expand the network size of the division of labour and increase per capita income compared with Hobbes' primordial state of nature if $t \in (t^*, t_0)$.

Proposition 1

If $t \in (t^*, t_0)$, a Sovereign generates a higher level of division of labour, higher aggregate productivity and higher per capita real income compared with Hobbes primordial state of nature through an increase in the institutional efficiency of enforcement of property rights.

Next, we examine the case where both countries have Sovereigns, but their personal consumption of the tax rate differs. We assume that $\beta_A < \beta_B$. We also assume that there are no border controls preventing population flows between Countries A and B.

Taking equation (3.17) into account, together with the Sovereign's budget constraint and the endogenous values of x^d and y^d, we can derive both the Sovereign's and the individual's utility functions with respect to the Sovereign's personal consumption rate, β.

$$(4.6) \quad u_{DS}(\beta) = \frac{\{4k^2 \cdot (1-\alpha) \cdot (2-\beta)^2 - t \cdot [2\sqrt{2}k(2-\beta) - 2t]\}^2}{128k^3 \cdot (2-\beta)^3}, \text{ and}$$

$$u_K(\beta) = \frac{M^2 \cdot \beta^4 \cdot \{4k^2 \cdot (1-\alpha) \cdot (2-\beta)^2 - \sqrt{2}t \cdot [2k(2-\beta) + 3\sqrt{2}t]\}^2}{256k^4 \cdot (2-\beta)^6}.$$

From the two above equations, it is clear that $\frac{\partial u_K(\beta)}{\partial \beta} > 0$, $\frac{\partial u_K(\beta)}{\partial M} > 0$, and

$\frac{\partial u_{DS}(\beta)}{\partial \beta} < 0$. These relationships indicate that with no border controls

preventing population flows between these two kingdoms, all individuals will

emigrate to the country with the lower β. Moreover, two Sovereigns will

reduce the level of β to attract more people to emigrate to their Kingdom,

thereby increasing u_K. The process of reducing the level of β will continue

until $u_K = u_{DS}$. We can derive the critical value of β, which is denoted as β_0,

from the following equation,

(4.7)

$$2k(2-\beta) \cdot [M\beta^2 - \sqrt{2}(2-\beta)^{\frac{3}{2}}] \cdot [2k(1-\alpha)(2-\beta) - \sqrt{2}t] - [6t^2M\beta^2 - 2\sqrt{2}t^2(2-\beta)^{\frac{3}{2}}] = 0 .$$

The critical value of β is,

$$(4.8) \quad \beta_0 \approx \frac{k(1-\alpha) \cdot (8M-1) - 4M \cdot t}{4(1-\alpha) \cdot k \cdot M} .$$

In (3.19), β^* is the equilibrium tax revenue share of a Sovereign's

consumption in a single kingdom without the threat of competition from

another kingdom. Since $\frac{d\beta_0}{dM} > 0$ and $\lim_{M \to \infty} \beta_0 = 2 - \frac{t}{k(1-\alpha)}$, we have $\beta_0 < \beta^*$.

Furthermore, comparing the per capita real income of the individuals in an economy with one Sovereign, compared with those in an economy with two Sovereigns yields the following relationship, due to $\frac{\partial u_{DS}(\beta)}{\partial \beta} < 0$,

$$(4.9) \qquad u_{DS}(\beta_0) > u_{DS}(\beta^*) \ .$$

Here, $u_{DS}(\beta_0)$ denotes the per capita real income of individuals in an economy with two sovereigns in two kingdoms, and $u_{DS}(\beta^*)$ denotes the per capita real income of individuals in an economy with one sovereign with Hobbes' state of nature in the other country.

Because of (4.9), an economy with two sovereigns in two kingdoms has a higher utility within the D^S structure than one with just one kingdom and one country still in a primordial state of nature. It follows that the extent to which $u_{DS} > u_A$ will be greater with two sovereigns who are in competition for labour flows compared to the situation where there is just one sovereign within the D^S structure. Therefore, rivalry between the two sovereigns assuming free migration between the kingdoms will promote division of labour.

These results can be summarized in the following proposition:

Proposition 2

Competition between Sovereigns generated by free migration between the two kingdoms will result in more effective third party protection for property rights. This, in turn, will expand the network size of the division of labour and productivity and reduce the income differential between the Sovereign and her subjects compared to the situation where there is just one Sovereign and the other country is still in Hobbes' primordial state of nature.

This result formalises the conjecture that political checks and balances should increase the share of tax revenue allocated to law enforcement as well as increase aggregate productivity, per capita real income and the division of labour. Montesquieu (1748 [1977]) was aware of this point over 250 years ago when contrasting the booming commercial economies of republican Holland and constitutional England with the stagnant economy of absolutist eighteenth-century France. Montesquieu (1748 [1977]) makes the observation:

> Great enterprises in commerce are not found in monarchical, but republican governments. …. [A]n opinion of greater certainty as to the possession of property in these [republican] states makes merchants

undertake everything. .... [T]hinking themselves sure of what they have already acquired, they boldly expose it in order to acquire more .... A general rule: A nation in slavery labors more to preserve than acquire; a free nation more to acquire than to preserve.

This point has been recognised by several modern commentators who draw a contrast between the economic effects of despotic states on one hand and constitutional or republican states on the other (see eg North and Thomas 1973, Brennan and Buchanan 1980, Olson 1991, 1993). These commentators argue that throughout history absolutist governments have implemented high rates of taxation which has discouraged commerce. In contrast, constitutional and republican governments set tax rates lower to encourage commerce and minimize the disruptive effect on the economy. The limited econometric evidence that is available also supports this view. De Long and Shleifer (1993) examine European city growth over an eight hundred year period prior to the Industrial Revolution. Their finding was that absolutist regimes were associated with lower levels of economic growth than limited monarchies or merchant oligarchies. They conclude that "'tax policies', broadly interpreted, are less favourable under autocrats than non-autocratic, often merchant-controlled, governments" (De Long and Shleifer 1993, p. 700).

Our model is a formal proof of what most economic historians recognize as accepted wisdom. Our results show that per cápita real income, productivity, and the income share of tax revenue is higher in a geopolitical structure where there are many sovereigns of nearly the same size than in a geopolitical structure with overarching political power. An example of the former is the European states' system from the seventeenth century, while examples of empires with overarching power include the Ottoman Empire in the Near East, Mughal Empire in India and the Manchu Empire in China before the nineteenth century (see eg Hall 1987, Mokyr 1993). Economic historians have long recognized that the geopolitical structure in Western Europe and the North Atlantic from the seventeenth century was favorable for the evolution of institutions and division of labor (see eg Jones 1981, North and Thomas 1973, Rosenberg and Birdzell 1986, North 1994). Kiernan (1965, pp. 31-32) argues that over this period the European monarchies could be likened to a series of joint-stock enterprises who vied to attract the services of entrepreneurs. Jones (1981, 115) generalizes Kiernan's argument to suggest: "in its state system Europe had a portfolio of competing and colluding polities whose spirit of competition was adapted to diffusing best practice".

Discussing the reasons for the emergence of capitalism in Europe, which he calls 'the European Miracle' Jones (1981, pp. 118-119) points out:

[T]here was, in essentials one technological community, a system where change in one cell tended to communicate to the remainder. Cultural connections and the competitive nature of the states system encouraged continual borrowing and the 'stimulus diffusion' which meant that if a problem were solved in one country, it was assumed that it could be solved in another. ... The states of Europe were surrounded by actual or potential competitors. If the government of one [was] lax, it impaired its own prestige and military security. If one politically or religiously prejudiced state excluded or expelled disfavoured groups of entrepreneurs or workers, other states of different complexions or greater tolerance might be bidding for services or be open to offers. The states system was an insurance against economic and technological stagnation. It was as if there were a kind of specie-flow equilibrating mechanism constantly levelling up know-how.

McNeill (1974, p. 125) expresses a similar view about the states system in Europe:

The political pluralism of early modern Europe was, I think,

fundamental and distinctive. When all the rest of the civilized world reacted to the enhanced power cannon gave to a central authority by consolidating vast, imperial states, the effect in western and central Europe was to reinforce dozens of local sovereignties, each consciously competing with its neighbors both in peace and, most especially, in war. Such a political structure acted like a forced draft in a forge, fanning the flames of rival ideologies and nurturing any spark of technical innovation that promised some advantage in the competition among states.

The rivalries between competing sovereignties created opportunities for social experiments with a wide range of institutions within a relatively short period of time. This rivalry also created intense pressure for rulers to creatively mimic those institutions that enhance economic performance, and therefore increase their power. In contrast to Europe, it is clear that the geopolitical structure in China, India and the Ottoman Empire hindered technological innovation. For example, Hall (1987, p. 33) states: "Pre-industrial empires [were] too centralized for their logistical capacity. ... Such empires sought to encourage the economy, but this form of government never ultimately allowed sufficient leeway to gather self-sustaining momentum". Jones (1981) also discusses the negative impact of large empires on innovation: He

suggests the Ottoman Empire did not develop because "[a] large empire which monopolized the means of coercion and was not threatened by more advanced neighbors had little incentive to adopt new methods" (Jones, 1981 p. 118).

In each of these empires property rights were insecure and there were high levels of arbitrary taxation used to finance the Monarch's personal consumption. As a result, although China came close to industrialization in the fourteenth century, from at least the sixteenth century the Asian empires increasingly fell behind the technological advances being made in Europe.[2] Huang (1974) discusses the lack of legal protection in Ming China:

> [I]n the late Ming [period] most of the service facilities indispensable to the development of capitalism were lacking. There was no legal protection for the businessman, ... merchants and entrepreneurs were hindered by the frequent roadblocks on trade routes, government purchase orders and forced contributions.

5. Conclusion

The objective of this paper has been to show how an improvement in institutional efficiency through the introduction of third party protection for property rights can lead to the division of labour, greater specialization and improvements in per capita real income. Instead of focusing on capital accumulation as a vehicle for growth, this paper stresses the importance of institutional factors, especially the enforcement of a property rights system, as central causes influencing the rate of structural transformation and the level of division of labour. We developed a two good consumer-producer model with endogenous specialization and endogenous stealing. A Sovereign's decision to collect tax and to allocate tax revenue between her consumption and enforcement of property rights was introduced to the model. By comparing self-protection and third party protection of property rights, we were able to show that the government can endogenously emerge from taxation that is introduced to finance the judicial system and enforcement of laws that penalize theft.

We used this framework to examine the trade off between the positive effects of third party property rights protection, and the negative effects of taxation on the network size of division of labour. We showed that improvements in

institutional efficiency expand the demand for transactions, which in turn increases the need for further third party protection of property rights. In our model, aggregate productivity is determined by the network size of the division of labour, or in Adam Smith's language, the extent of the market. The network size of the division of labour is determined by the enforcement of property rights, which is dependent on the level of taxation revenue. Taxation revenue, in turn is dependent on productivity and the network size of division of labour, which generates a powerful circular effect driving economic growth and promoting economic welfare.

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[1] The specification of iceberg transaction costs, such as this, are common in equilibrium models with trade-offs between increasing returns and transaction costs – see Krugman (1995). The specification avoids notoriously difficult index sets of destinations and trade-flows.

[2] The opinions of historians are divided on how big the gap was. Some historians, such as Graham (1973), argue that Chinese science merely advanced more slower than in Europe, while others, such as Elvin (1973), argue that Chinese science went backwards over this period.

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