The Role of Trade in Amplifying Crime

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Abstract

The variance in crime rates across countries is much larger than the variance in income or inequality. This paper is the first to provide an explanation for this magnitude of variance. We add a “crime” sector to a standard Heckscher-Ohlin model, to understand the impact of trade flows on crime rates. Under autarky, all countries have the same crime rate. But trade is found to increase crime in the resource-rich country and to reduce crime in the labor-rich country by an equal amount. The negative externality from increased crime can even be strong enough to cancel out the gains from trade for a resource-rich country. This model can explain the rise in crime in middle-income countries such as Latin America as lower-income countries lower trade barriers. The model also shows that foreign aid and highly mobile export-oriented industries can have unexpectedly negative consequences.

Journal of Economic Literature Classification Numbers: F11, F13, O17

Keywords: crime, trade, gains from trade, resource curse

1 Introduction

The most striking feature of crime rates is the variation across countries. Victimization surveys indicate the burglary rates are 20 times higher in the worst affected country, relative to the least affected [Soares, 2004]. The homicide rate in a number of low-income countries in Asia (including India) is below 5 per 100,000 inhabitants, while it is over 20 per 100,000 in thirteen Latin American countries, and reaches 65 per 100,000 [UNODC, 2011]. The variation cannot be explained solely by drug trafficking or civil unrest. Latin America has seen a doubling of homicides and a tripling of property crime in the last twenty years [Bergman, 2006], yet the volume of drug production has remained stable [Chalk, 2011]. And there are countries with high homicide rates (for example, in Africa) that are not affected by sectarian violence or the drug trade [UNODC, 2011].

The variation in crime rates is important because when crime rates reach extreme levels, economic activity is severely curtailed. There is a large literature demonstrating the importance of secure property rights for production and investment [Dixit, 2009], although less literature on
crime specifically.\footnote{Several authors document the welfare cost of crime in poor countries ([Bourguignon, 2000], [Pradhan et al., 1999], [Soares, 2006]). But there is little research on the impact of crime on economic activity. The challenge is the empirical difficulty in untangling the effect of crime on the economy from the effect of a weak economy on crime (as recognized by [Bourguignon, 2000] and [Fajnzylber et al., 2002]). [Raphael and Winter-Ebmer, 2001] deal with this reverse-causality in their study of the effect of unemployment on crime, but do not derive estimates of the effect of unemployment on crime.} It is clear that widespread crime imposes costs on local industries: for example, [BenYishay and Pearlman, 2014] show that Mexican microenterprises experienced lower growth and investment after an increase in property crime. Moreover, industries such as export processing that are mobile across regions and across borders will choose to locate elsewhere: for example, [Altindag, 2014] has shown that crime harms the tourism industry, because tourists choose other locations. Finally, [Cullen and Levitt, 1999] have shown that crime in cities drives highly-educated workers to relocate.

What can explain these large variations in crime rates?\footnote{One important explanatory factor in low-income countries is inequality. [Demombynes and Özler, 2005] and [Bourguignon et al., 2003] find a relationship between inequality and crime and South Africa and Colombia, respectively. [Soares, 2004] finds a similar role for inequality in a cross-country regression, and [Gibson and Kim, 2008] find a weak relationships. Another important factor for lower-income countries (and Europe in earlier periods) is spikes in fuel and food prices ([Fafchamps and Minten, 2006], [Brantingham and Brantingham, 1984]). While these are all likely explanatory factors, these papers have not explained why such large and persistent differences arise.} The most recent strand of this literature looks at factor endowments, examining how the terms of trade affect the returns to wage work and to crime ([Ghosh and Robertson, 2012] and [Dal Bó and Dal Bó, 2011]). By modeling crime as an “industry” with its own labor intensity, they can predict the occupational choice of workers across industries and the effect of factor price changes on crime. However, while this literature makes progress in explaining the direction of the impact of trade, it does not address the question of magnitude. In part this is because the analysis is not fully-general equilibrium: these papers study how a change in the terms of trade affects crime, but the terms of trade are not endogenized.

Using a classical Heckscher-Ohlin framework, this paper is able to make several important predictions about how trade affects the magnitude of crime rates, and how crime in turn affects the gains from trade. There are two countries and two factors of production – labor and ‘capital’ which can be thought of as physical capital and/or natural resources. In line with the models above, we add a labor-intensive crime sector that preys on the productive sectors of the economy. The decision to engage in crime is a purely economic one: thus the payoff to labor is equalized across sectors. For simplicity, we rule out investments in security and investments in law enforcement. Thus the model’s predictions will line up poorly with outcomes in wealthy countries with well-resourced law enforcement.

We find that in autarky, both countries have the same crime rate. But opening up to crime reduces crime in the labor-rich country and raises crime in the capital-rich country. Interestingly, the total amount of crime is unchanged, but trade “relocates” crime from the labor-rich to the capital-rich country. If we interpret ‘capital’ as natural resources, this gives us another version of the “resource curse” [Besley and Persson, 2011]: resource-rich countries have more incentive to
engage in crime. Trade brings the two locations’ wages closer together, as in classical trade theory, but the returns to crime are higher when a country has more output per worker. This theory can explain why the countries in Latin America, which are relatively rich in capital and mineral resources, experienced a sharp increase in crime when labor-rich China entered world trade.

The model suggests that the impact on crime rates of greater openness to trade can be extreme. In fact, the rise in crime and resulting loss in GDP can be so significant that a country can be worse off from opening up to trade. This welfare loss is more likely when there exists a strong preference for the capital-intensive good, which is precisely the conditions under which a capital-rich country expects to gain from trade.

The model has some interesting policy implications. For example, migration from poor to wealthy countries, which is often argue to aggravate crime, is shown instead to reduce incentives for crime. Foreign aid has been shown to aggravate some political struggles over resources in countries with weak institutions [Besley and Persson, 2011]. We show that foreign aid also aggravates crime, by raising the gains to criminal activity. Indeed receiving foreign aid can make a country worse off.

On another topical question, there has been debate over the benefits of attracting highly mobile export-oriented industries. We show that such industries can have a stabilizing effect on crime if they are labor-intensive, but a highly destabilizing effect on the economy if they are capital-intensive.

The paper proceeds as follows. Section 2 reviews the literature. Section 3 sets up the model. Section 4 presents results on how crime rates are affected by opening up to trade, and the welfare implications. Section 5 describes some of the implications of these results for the specialization of each country. The implications of mobile factors and industries are described: there are results on the effect on crime rates of aid, immigration, and the potential relocation of industries such as tourism that are sensitive to local conditions. Section 6 concludes.

2 Literature Review

There is a macroeconomic literature aiming to explain patterns in crime rates. For example, [Bethencourt and Perera-Tallo, 2015] formulate a Solow model with crime, in which crime falls over time as labor earns a greater share of the value of production. [İmrohoroğlu et al., 2004] generate patterns in crime rates that accord with US data, using exogenous changes in demographics and enforcement.

One strand of this literature has sought to formulate an explicit crime technology, rather than leave it as a ‘black box’ in which losses are function of the number of criminals. These papers use

\(^3\)Note however that this effect ignores some of the sociological motives for crime, such as the marginalization of second-generation immigrant youth.
search-and-matching models of crime, originally developed in political economy. ([Grossman and Kim, 1995] and [Skaperdas, 1992] among others have studied economies in which agents must decide how to allocate their time between producing output, defending their output from attackers, and attacking others. Without a government with the power to enforce property rights, property rights are only secure under certain values of the attacking and defending technologies.) But these matching models frequently yield multiple equilibria, which are difficult to interpret. [Roland and Verdier, 2003] sought to explain the explosion of crime in Russia after the Soviet era. They include a government sector, and the government’s tax and enforcement technology generates multiple equilibria: when there are many criminals, there may not be enough legal income to tax for effective law enforcement. [Burdett et al., 2003] embed the choice to engage in crime in a labor search model, with an exogenous rate of apprehension: they also find a Pareto-inferior equilibrium in which everyone engages in crime (but [Engelhardt et al., 2008] find a unique equilibrium when labor contracts are optimal). [Glaeser et al., 1996] seek to explain huge geographic variation in crime, similarly to our paper. Their paper considers how peer effects in one’s social network can lead to multiple equilibria in crime rates.

Most of this literature treats each region as a closed economy, and ignores spillovers between regions. The first to do otherwise were [Freeman et al., 1996], in a microeconomic model. They modeled criminality in neighborhoods, and allowed criminals to choose which neighborhood to target; again, they found multiple equilibria.

A new line of research considers how world prices might affect crime rates in an economy. [Ghosh and Robertson, 2012] studied the effect of a declining import price on a small open economy. They found that if crime uses unskilled labor, and changes in world prices reduce unskilled wages, then crime will increase. [Dal Bó and Dal Bó, 2011] likewise model a small open economy, using a two-factor two-industry setup similar to this paper. An increase in the world price of the capital-intensive good leads to more crime. They also find that crime augments the share of labor devoted to capital-intensive production, because crime draws workers from the pool of effective labor; we echo these predictions. These two papers allow for crime enforcement at levels chosen by a social planner; in contrast, [Stefanadis, 2010] considered how international trade affects the amount of crime enforcement that the majority will vote for.

These papers assess the direction of the change in crime rates, but not the magnitude of the change. World prices are left exogenous, and in many of these papers ([Dal Bó and Dal Bó, 2011], [Stefanadis, 2010]) the crime technology is once again a black box, which eliminates the risk of multiple equilibria, but does not allow for precise predictions. But the effects identified are only interesting if the magnitude is large. Moreover, if these effects are large, they have implications for world prices as well, and so prices should be endogenized. We will explore this effects in a
model with endogenous world prices and an explicit crime technology that allows us to make more specific predictions.

3 Model Setup

We begin with a standard Heckscher-Ohlin model with two goods, two factors and two countries, to which we add a “crime sector.” Goods $X$ and $Y$ are produced from capital and labor in country $i$ (representing countries A and B):

$$X_i = k_{xi}^\alpha L_{xi}$$

$$Y_i = k_{yi}^\beta L_{yi}$$

where $k_{xi}$ and $k_{yi}$ are the capital-labor ratios in industries $X$ and $Y$, in country $i$. $Y$ is the capital-intensive industry, so $0 < \alpha < \beta < 1$. B is the capital-abundant country: $\frac{K_B}{N_B} > \frac{K_A}{N_A}$, where $N$ is the population. As this is a two-sector model and therefore limited in dimensions, we take $K$ to mean both physical capital and any resource endowment, combined.

3.1 The Crime Sector

We add a third sector (“crime”) that preys on the other two sectors.

We follow those papers that explicitly model how agents incur losses from crime or insecure property rights, so that relationship between agents’ losses and the size of the sector is well-grounded. The cost of crime is determined by two ‘technologies’: (1) the attacking technology, which determines how successful a criminal is in a struggle with a victim; and (2) the matching technology, which determines the probability with which criminals meet a potential victim. As for (1), we will assume that a robber carries off a share $s$ of goods; or equivalently, with probability $s$ he takes everything. For simplicity, we assume that there is no collateral damage from crime; it is a straight transfer of goods.

As for (2), we assume simple random matching, similarly to [Roland and Verdier, 2003], bearing in mind that richer models yield similar results. To keep things simple, we assume that criminals attack firms, rather than preying on both firms and consumers. We furthermore assume that all firms have a minimum efficient scale of $n$ workers. We thereby eliminate the unfortunate feature of multiple equilibria that some models possess (e.g. [Ghosh and Robertson, 2012], [Grossman and Kim, 1995]): if a criminal can steal one worker’s worth of goods, or instead can produce one worker’s worth of goods, then an equilibrium with zero crime always exists. Assumption 1 will be sufficient to rule out a zero-crime equilibrium:
Assumption 1. $sn > 1$

Thus, if there are $L_x$ workers in industry $X$ and $L_y$ workers in $Y$, there are $\frac{L_x}{n}$ and $\frac{L_y}{n}$ firms of type $X$ and $Y$ respectively, and $(N - L_x - L_y)$ criminals. (We omit country subscripts from this subsection, for simplicity.)

Under random matching, the probability that firm will find itself matched with a criminal is equal to the proportion of criminals within the pool of {firms plus criminals}, which is

$$q \equiv \frac{N - L_x - L_y}{(N - L_x - L_y) + \frac{L_x}{n} + \frac{L_y}{n}}$$ \hspace{1cm} (3)

If it is attacked, the firm will lose a share $s$ of its output. Thus the firm expects to retain a share $(1 - qs)$ of its output. Notice that, because matching is random, industry $X$ and $Y$ both lose the same share $qs$ of output. Crime will not affect the relative profitability of industry $X$ and $Y$.

The probability that a criminal is matched with a firm from industry $X$ is equal to their share in the pool: $q_x \equiv \frac{\frac{L_x}{n}}{(N-L_x-L_y) + \frac{L_x}{n} + \frac{L_y}{n}}$. He will then capture a share $s$ of the firm’s output. And likewise the probability of encountering a firm from industry $Y$ is $q_y \equiv \frac{\frac{L_y}{n}}{(N-L_x-L_y) + \frac{L_x}{n} + \frac{L_y}{n}}$.

3.2 Equalization of returns to crime and wage work

We assume that crime is an activity that requires no capital, only labor. Workers move from the legal sector to the criminal sector when the returns to crime are higher. Thus in equilibrium the returns to all activities are equalized within a country.

Wages in $X = Wages in Y = Expected Earnings from Crime$

In a perfectly competitive equilibrium, workers will be hired into sector $X$ until the wage equals the marginal product of labor. The marginal product of labor is proportionally lower, because of losses due to crime. Thus we can re-write this equation as:

$$(1 - qs)MP_x = (1 - qs)MP_y = q_x s \times nAP_x + q_y s \times nAP_y$$ \hspace{1cm} (4)

$MP_x$ is the marginal product of labor in industry $X$, and $AP_x$ is the average product of labor in industry $X$. The value of the output of an $n$-person firm is $n$ times the average product of labor. The right-hand side of this equation is a criminal’s expected earnings: there is the probability of a match with an industry $X$ firm, multiplied by the value of the goods stolen from an industry $X$ firm, plus a similar term for industry $Y$. (Notice that we are implicitly assuming frictionless crime: no share of goods is ‘lost’ during crime; and criminals care only about the value of the goods stolen, implying that they can be re-sold if necessary.)
This form of the equation allows us to foresee the main result. The payoff to legal work is proportional to the marginal product of labor. The payoff to crime is proportional to the average product of labor in both sectors. What drives a wedge between marginal and average product? Capital intensity. The ratio of average product to marginal product is larger in industry Y, where capital is more productive. As a result, if a change in trade flows causes industry Y to expand, the returns to crime will go up sharply and the size of the criminal sector will expand.

Equation (4) can be greatly simplified, using the fact that not only wages, but also returns to capital, are equalized across sectors by firms. For each country $i$,

$$
\begin{align*}
    w_{xi} &= (1 - qs)p(1 - \alpha)k_{x1}^\alpha = w_{yi} = (1 - qs)(1 - \beta)k_{yi}^\beta \\
    r_{xi} &= (1 - qs)p\alpha k_{x1}^{\alpha-1} = r_{yi} = (1 - qs)\beta k_{yi}^{\beta-1}
\end{align*}
$$

(5)

Notice that the effect of crime $(1 - qs)$ drops out of these equations.

Equation (4) becomes:

$$
1 - q = q_x \frac{sn}{1 - \alpha} + q_y \frac{sn}{1 - \beta}
$$

Replacing $q$, $q_x$ and $q_y$ with their values and simplifying:

$$
N_i = \left( \frac{n - 1 + sn}{n - ns} \right) L_{xi} + \left( \frac{n - 1 + sn}{n - ns} \right) L_{yi}
$$

(6)

Equation (6) will replace the normal condition on the total supply of labor, $N_i = L_{xi} + L_{yi}$. Both these parameters are larger than 1, since $ns > 1$, which implies that crime reduces the total amount of labor available. The parameter on $L_{yi}$ is larger than the parameter on $L_{xi}$, because $\alpha < \beta$, which implies that when the share of labor devoted to the capital-intensive industry (Y) grows, crime grows as well.

Table 1 lays out the equilibrium conditions for the model, in the absence of crime and in the presence of crime$^4$ (see Appendix 7.1 for the derivation). Table 1 highlights that labor condition (6) is the only difference between the equilibrium conditions in a normal Heckscher-Ohlin trade model, and our new equilibrium conditions in the presence of crime. (The remaining conditions are derived from the equalization of returns to capital and labor across industries in (5), and the utility-maximization of consumers which implies $p_i = \frac{Y_i}{\gamma X_i}$ when in autarky, and $p = \frac{Y_i + Y_j}{\gamma(X_i + X_j)}$ when trade equalizes prices across countries.) The explicit solutions to these conditions are presented in Table 2.

$^4$Note however that the equations only hold in the so-called “cone of diversification,” that is, the range of parameters for which both goods are produced in both countries after trade.
**Table 1:** Equilibrium conditions for labor allocation under autarky and under trade, in the cone of diversification

<table>
<thead>
<tr>
<th>Autarky No Crime</th>
<th>Trade No Crime</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{yi} = \gamma \frac{1-\beta}{1-\alpha} L_{xi}$</td>
<td>$L_{yi} + L_{yj} = \gamma \frac{1-\beta}{1-\alpha} (L_{xi} + L_{xj})$</td>
</tr>
<tr>
<td>$N_i = L_{xi} + L_{yi}$</td>
<td>$(L_{xi} + \frac{\beta (1-\alpha)}{\alpha (1-\beta)} L_{yj}) K_j K_i = L_{xj} + \frac{\beta (1-\alpha)}{\alpha (1-\beta)} L_{yj}$</td>
</tr>
<tr>
<td></td>
<td>$N_i = L_{xi} + L_{yi}$</td>
</tr>
</tbody>
</table>

<table>
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<th>Trade with Crime</th>
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</thead>
<tbody>
<tr>
<td>$L_{yi} = \gamma \frac{1-\beta}{1-\alpha} L_{xi}$</td>
<td>$L_{yi} + L_{yj} = \gamma \frac{1-\beta}{1-\alpha} (L_{xi} + L_{xj})$</td>
</tr>
<tr>
<td>$N_i = \left( \frac{n-1+sn}{n-ns} \right) L_{xi} + \left( \frac{n-1+sn}{n-ns} \right) L_{yi}$</td>
<td>$(L_{xi} + \frac{\beta (1-\alpha)}{\alpha (1-\beta)} L_{yj}) K_j K_i = L_{xj} + \frac{\beta (1-\alpha)}{\alpha (1-\beta)} L_{yj}$</td>
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</tr>
</tbody>
</table>

Table 2: Labor allocation under autarky and under trade, in the presence of crime (when parameter values are in the cone of diversification). We adopt several changes of variables, for visual clarity:

- $\theta = \frac{\alpha (1-\beta)}{(1-\alpha) \beta}$
- $\sigma = \frac{1-\beta}{1-\alpha}$
- $c = \frac{(1-s)n}{n-1+sn}$
- $a = \frac{n-1+sn}{n-1+sn}$
- $\gamma = \frac{1-\beta}{1-\alpha}$
- $\sigma = \frac{1-\beta}{1-\alpha}$
- $\alpha = \frac{n-1+sn}{n-1+sn}$
- $\beta = \frac{n-1+sn}{n-1+sn}$

**Table 2:** Labor allocation under autarky and under trade, in the presence of crime (when parameter values are in the cone of diversification). We adopt several changes of variables, for visual clarity:

<table>
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<th>Autarky with Crime</th>
<th>Trade with Crime</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{xA} = \frac{c N_A \gamma}{a+\gamma \sigma}$</td>
<td>$L_{xA} = \frac{c K_A K_B}{R_A + R_B} \left[ \frac{N_A + N_B \gamma}{a+\gamma \sigma} \right] + \frac{N_A K_B - N_B}{a-\theta}$</td>
</tr>
<tr>
<td>$L_{yA} = \frac{c N_A \gamma}{a+\gamma \sigma}$</td>
<td>$L_{yA} = \frac{c K_A K_B}{R_A + R_B} \left[ \frac{(N_A + N_B \gamma) \gamma}{a+\gamma \sigma} \right] - \frac{(N_A K_B - N_B) \gamma}{a-\theta}$</td>
</tr>
<tr>
<td>$L_{xB} = \frac{c N_B \gamma}{a+\gamma \sigma}$</td>
<td>$L_{xB} = \frac{c K_A K_B}{R_A + R_B} \left[ \frac{N_A + N_B \gamma}{a+\gamma \sigma} \right] + \frac{N_B K_A - N_A}{a-\theta}$</td>
</tr>
<tr>
<td>$L_{yB} = \frac{c N_B \gamma}{a+\gamma \sigma}$</td>
<td>$L_{yB} = \frac{c K_A K_B}{R_A + R_B} \left[ \frac{(N_A + N_B \gamma) \gamma}{a+\gamma \sigma} \right] - \frac{(N_A K_B - N_B) \gamma}{a-\theta}$</td>
</tr>
</tbody>
</table>
4 The Amplification of Crime in Labor-Poor Countries

4.1 The Impact of Trade on Equilibrium Crime

We are now in a position to state our first proposition.

**Proposition 1:**

(a) Under autarky, both countries have the same crime rate.

(b) When parameter values are in the cone of diversification (that is, both countries produce both goods after trade): Trade raises crime in the capital-abundant country by exactly the same amount as trade reduces crime in the labor-abundant country. The total amount of crime is unchanged. The difference in crime rates is proportional to the difference in factor endowments, hence it is increasing in the relative capital abundance of country B.

(c) Outside of the cone of diversification, trade raises crime even further in the capital-abundant country, and lowers it even further in the labor-abundant country.

**Proof:** Prop 1(a) follows directly from Table 2, which shows that in autarky, both countries devote the same share of labor to industry \(X\) and industry \(Y\); therefore the share of labor remaining in crime is the same as well. See Appendix 7.2 for Proposition 1(b) and 1(c), and the stability of equilibrium under autarky and trade is verified in Appendix 7.3.

It is straightforward to see why crime rises in the capital-rich country. We use a proof by contradiction: suppose that the two countries had identical crime rates after trade. If crime rates were identical, then the standard Heckscher-Ohlin result would hold, and factor returns would be identical across countries. The wage rate in country \(i\) is equal to \((1 - q_i s)p(1 - \alpha)k_{xA}^\alpha\) (Equation 4), where \(q_i\) indicates the value of \(q\) (the probability of meeting a criminal) in country \(i\). Appendix 7.1 shows that \(k_{xA} = k_{xB}\) when there is free trade. Therefore if crime rates were identical across countries, \(q_A = q_B\) and the wage rates across countries would be identical. Workers would receive the same wages in the capital-rich and capital-poor country. Yet crime would be much more profitable in the capital-rich country, because output per worker is larger, which implies a contradiction. Thus the crime rate in the capital-rich country must be higher.

If we interpret \(K\) as including natural resources as well as physical capital, then Proposition 1 is another version of the “resource curse”: a country with greater resources will have more conflict over those resources [Bates et al., 2002]. Several papers have found evidence of welfare-decreasing political conflict over resources ([Sachs and Warner, 2001] and [Berman et al., 2017] among others5) and we are suggesting that resources can also create greater incentives for crime.

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The interesting twist is that this new resource curse arises only in the presence of trade: in autarky, greater resources do not imply more crime.6

4.2 The Magnitude of the Effect of Trade on Crime

This model is able to generate sizeable variation in crime. For example, it is not difficult to identify parameter values of which total legal employment can drop by more than 50% with the advent of trade, because so many agents move into the criminal sector.7

The model is able to replicate the differences in crime rates that we observe across countries. For example, the introduction mentioned that crime rates (as proxied by homicide rates, the most reliable source of data) are over four times higher in Latin America than in most low-income countries in Asia (over 20 per 100,000 compared to under 5 per 100,000). Can we find resource endowments for which the crime rate in country B is four times as high as in Country A? Table 2 indicates that the crime rate in country $i$ is:

$$\frac{N_i - L_{xi} - L_{yi}}{N_i} = 1 - \frac{c}{N_i(K_i + K_j)} \left[ K_i(N_i + N_j)(1 + \gamma \sigma) \frac{a + \gamma \sigma}{a - \theta} + \frac{(N_iK_j - N_jK_i)(1 - \theta)}{a - \theta} \right]$$

The crime is rate is four times as high in Country B if

$$\frac{N_B - (L_{x,B} + L_{y,B})}{N_B} > 4 \left( \frac{N_A - (L_{x,A} + L_{y,A})}{N_A} \right):$$

this condition simplifies to

$$\left( 1 + \gamma \sigma \right) \left( \frac{4K_A - K_B + 4 \frac{N_B}{N_A} K_A - \frac{N_A}{N_B} K_B}{K_A + K_B} \right) + \left( 1 - \theta \right) \left( \frac{4K_b - K_A + 4 \frac{N_A}{N_B} K_B - \frac{N_B}{N_A} K_A}{K_A + K_B} \right) > 3c$$

Let us think of Country B as ‘South America’ and Country A as ‘South Asia’, and assume that the two countries have equal-sized capital endowments, and country A has three times as many people.8) For these endowments, the value of each bracket is roughly 2.3. Given that $1 < \frac{1 + \gamma \sigma}{a + \gamma \sigma} < \frac{1 - \theta}{a - \theta}$ (as shown in Appendix 7.2) and $c < 1$, this condition is satisfied for any value of the other parameters, and the crime rate in Country B is more than four times as large.

We now turn to the central welfare question: Can negative externalities from crime outweigh the benefits of engaging in trade? Specifically, under what circumstances is country B worse off with free trade than in autarky, because of the increase in crime?

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6See [Garfinkel et al., 2015] for a model of the effect of trade on the resource curse.

7For example, let $N_A = N_B = 100$, $K_A = 100$ and $K_B = 200$. Let $\alpha = 0.2$, $\beta = 0.8$, $\gamma = 0.5$, $n = 10$ and $s = 0.8$. Then it is easy to show that we are out of the cone of diversification, and after trade there is no sector X in country B. In this example, employment falls by 65% after trade.

8We rely on data from the Penn World Tables in 2010: South Asia is defined as Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. Afghanistan is usually categorized as part of South Asia, but data was unavailable. ‘Capital’ is defined as physical capital, and excludes resources; including resources would intensify the capital advantage of South America. Based on this data, South Asia has 47% of the total capital, and 77% of the total population.
Proposition 2: In the presence of crime, a capital-rich country can be worse off with free trade than in autarky.

(a) Trade will render the capital-rich country worse off if and only if

\[ z^{1-\frac{\alpha+\beta}{1+\gamma}} > 1 + (z - 1) \left( \frac{1 - \frac{\alpha}{\beta}(a + \gamma)}{(a - \frac{\alpha(1-\gamma)}{(1-\alpha)\beta})(1 + \gamma)} \right) \]

where \( z \equiv \frac{kA}{KB} + 1 \) and \( a \equiv \frac{n-1+s\alpha}{n-1+s\beta} \).

(b) A sufficient condition for trade to render a capital-rich country worse off is \( s > \frac{n-1}{n} \).

Proof: See Appendix 7.4.

The sufficient condition in (b) seems straightforward: an extremely powerful attacking technology (a very high \( s \)) will mean that crime rises dramatically when the payoff to crime increases.

The more interesting part of this proposition is the necessary condition in (a). This condition is satisfied over broad ranges of the parameter space, implying that there are many parameter values for which crime eliminates the gains from trade. For example, if we consider the gains to trade as a function of \( z \), taking very standard values of the other parameters, for example \( s = 0.7 \), \( \alpha = 0.3 \), \( \beta = 0.7 \), \( \gamma = 0.5 \) and \( n = 10 \), and \( s \) from 0.5 to 1, trade leads to net welfare losses for all values of \( z \) above 0.1, that is, unless country A has a huge population relative to country B. This is of concern, as in the absence of crime, the gains to trade would be substantial over much of this range.

Another interesting point is that trade is more likely to make the capital-rich country worse off when \( \gamma \) is large, that is, when consumer preferences are oriented toward the capital-intensive good. In that case, trade will sharply expand the output of the capital-intensive good, and with it, the crime rate.

4.3 Discussion: Equilibrium Crime and Law Enforcement

How well do these predictions of the model match the empirical realities? First we consider the prediction that trade will raise crime in comparatively capital-rich countries, and and lower crime in comparatively capital rich countries. If we restrict attention to low and middle-income countries, the predictions do not seem unreasonable. The rise of China and India has coincided with an extremely sharp rise in crime in the middle-income region of Latin America, which is comparatively capital-rich and resource-rich. Indeed, detailed empirical work has directly connected the rise in crime in one region of Latin America to trade liberalization [Dix-Carneiro et al., 2016]. At the same time, crime has stayed relatively low in the labor-rich countries of Asia, who were initially
much poorer.\footnote{Crime has increased substantially in China over this period, which appears to contradict the predictions. However, this may be explained by the fact that Eastern China is undergoing an industrial transition over this period, and effectively becoming a capital-rich country: the majority of this increase in crime has taken place in the wealthy industrialized Eastern provinces [Cheong and Wu, 2015].}

The model fares less well in its predictions for wealthy countries. While several papers have confirmed that trade liberalization puts pressure on wages for low-skill workers in wealthy countries [Autor et al., 2014], with the resulting societal strains, this has not translated into a rise in overall crime rates. There are two explanations for why this is not the case.

First, we have not incorporated law enforcement into our model of crime. If the government has no budget constraint and if enforcement costs are convex (as in [Ghosh and Robertson, 2012]), then incorporating law enforcement will not change the direction of results: crime will go down in the labor-rich country and up in the labor-poor country. But if wealthier countries can afford more law enforcement, and can use the gains from trade for law enforcement, then this could potentially reverse results. Thus we focus our attention mainly on middle and low income countries, in which limited government budgets and some challenges with corruption imply that law enforcement is less effective against crime.

Second, crime in wealthy countries is not purely driven by economic forces such as wages and the gains to crime. Participation in crime is also driven by a broad range of social factors. For example, research finds that the large decline in crime in the US in the 1990s is due to a waning of the crack epidemic, the legalization of abortion in the 1970s, and factors related to enforcement (increases in police numbers and in prison populations) [Levitt, 2004]. Wages and employment played much less of a role.

As an illustration, Figure 1 graphs homicides per capita against natural resources per capita. The homicide data is from the United Nations Office of Drugs and Crime [UNODC, 2011]. We use 2011 data when 2012 data is missing. Data on resource endowments per capita in 2005 are from the World Bank; resource endowments is the sum of the value of stocks of crop, pasture land, timber, non-timber forest, protected areas, oil, natural gas, cola and minerals [World Bank Group, 2011]. There is a positive correlation between resource endowment and homicides if we consider only the bottom two-thirds of countries by GDP per capita: the correlation is 0.202. But that correlation disappears (to -0.09) when we include the top third of countries.

The second prediction, from section 4.2, states that the rise in crime can make countries worse off. This stylized result is designed to point out that the negative externality of increased crime can be very serious. As discussed in the introduction, there is a dearth of research on the cost of crime to economic activity, and even less on its interaction with trade. One could look at Africa to see a region in which insecurity in property rights has arguably made many countries worse off [Collier, 2008]. However, incomes in most other regions of the world have been rising in the long
term, although certain high-crime countries such as Brazil or Papua New Guinea have seen periods of declining real GDP, and rising crime was one component of the economic turmoil.

5 Further Results: Specialization and Factor Mobility

5.1 The Effect of Crime on Specialization

If trade can have a large effect on crime rates, it is also having a large effect on the labour supply to the ‘legal’ sectors. We consider what this means for specialization in each country. We find that crime has the unexpected effect of intensifying the specialization of each country (as found in [Dal Bó and Dal Bó, 2011]).

Proposition 3:

(a) Crime leads to a greater specialization in trade: The capital-rich country has a larger share of the capital-intensive industry than it would in the absence of crime. This holds true even though crime reduces the country’s employment and hence its output.

(b) The cone of diversification (the range of parameter values over which both countries produce both goods) is smaller than if there were no crime. Thus countries specialize in just one industry over a wider range of parameter values.

Proof: See Appendix 7.5.

Intuitively, if the crime rate goes down in the labor-rich country, a larger share of the population is legally employed than before, so that country becomes more labor rich. Likewise, the labor-poor
country becomes even more labor-poor when trade raises its crime rate. This result is not so surprising: when countries are resource-rich and crime-ridden, then unsurprisingly the resource sector constitutes a huge share of exports. What is surprising is that this specialization effect dominates the overall fall in employment and output in the capital-rich country: country B’s share of the capital-intensive industry is larger than in the absence of crime.

The effect of crime on trade volumes is indeterminate. Because of greater specialization, a greater share of output Y is traded in the presence of crime. However, crime can have such a negative effect on employment that overall trade volumes could be smaller.

5.2 Corollary: Results on Factor Movements

Proposition 1 has some immediate implications for the effect of factor movements: we can immediately tease out the effect of a migration of workers, or of a redistribution of capital.

“Capital” in this model has been interpreted as including physical capital and resources more generally. If we further extend the definition to include financial capital, we can think about the effect of an inflow of financial capital.

Corollary 1: Foreign Aid

Aid from the capital-rich to the labor-rich country (or from a third party to the labor-rich country) would worsen crime in the labor-rich country.

This accords with [Besley and Persson, 2011] results on the effect of foreign aid in environments without cohesive institutions. The corollary follows directly from the results in Proposition 1, as outlined in Table 2: the population share of legal employment, and by extension the population share of criminals, is a linear function of the relative capital and labor abundance in the two countries, $K_A/N_A$ and $K_B/N_B$. (If $K_A/N_A = K_B/N_B$, then after trade the two countries would have the same autarky crime rate. The returns to crime would not be higher in Country B, because output per worker would not be higher in Country B.) Foreign aid would bring these ratios, and therefore the crime rates, closer together. Therefore foreign aid would have a negative impact on the crime rate in the receiving country.

Corollary 2: Factor movements

(a) Factor price equalization does not hold in the presence of crime. If $(1 - qs)$ is the expected share of output retained by firms, payments to labor and capital in country $B$ are lower than in country $A$.

(b) Therefore, under the assumptions of identical productivities and frictionless trade, factors would flow away from the capital-rich country. Capital flows would reduce crime in the
capital-rich country, but labor flows would increase crime in the capital-rich country. If capital is mobile but labor is immobile, crime rates will diverge even further, and in equilibrium at least one country fully specializes in producing one good.

(c) Suppose there existed trade frictions or differences in productivity that implied that wages were higher in the capital-rich country, despite differences in the crime rate. If workers could migrate, they would migrate from the labor-rich country to the capital-rich country. Migration into the capital-rich country would reduce its crime rate.

PROOF of 2(b): See Appendix 7.6.

Recall that the wage rate in country \( i \) is equal to \((1 - q_i s)p(1 - \alpha)k_xi\), where \( q_i \) indicates the value of \( q \) (the probability of meeting a criminal) in country \( i \), and free trade means that \( k_{xA} = k_{xB} \) (same factor intensities). Thus wages are proportional to \((1 - q_is)\), the share of output not lost to criminals. Wages are lower in the capital-rich country because the crime rate is higher.

Again, this result holds because the difference in crime rates across countries is driven by their relative factor endowments, relative capital and labor abundance in the two countries, \( K_A/N_A \) and \( K_B/N_B \). Factor movements that bring those ratios closer together, such as a capital flow to the labor-rich country or migration to the capital-rich country, will bring the crime rates closer together. What is interesting is that the returns to factors are affected by the local crime rate. Thus, in the unlikely event that trade was frictionless and countries had the same productivity, we would actually see higher wages and returns to capital in the poorer country.

The most empirically applicable result from this corollary concerns the case in which factor returns are higher in the wealthier country because of productivity differences. In that case, there would be migration towards the wealthier country, and this migration would lead to a reduction in crime. The intuition is that migration increases the labor resources of the capital-rich country, and the relative factor endowments of the two countries become more similar. The returns to crime are no longer as high in the wealthy country, because output per worker is not as high. This is an interesting result, because migrant groups are frequently blamed for any rise in crime. Again, it is important to stress that we are presenting a purely economic model of crime, and this simple model does not include unemployment. Many of the factors that drive marginalized immigrant groups (and their children) into crime in wealthy countries are not modeled here.

5.3 Corollary: Footloose Industries

The final type of mobility we consider is mobility of specific industries. With the growing importance of Special Export Zones on some continents, and the rise of maquiladoras since NAFTA, the issue of highly mobile industries has gained greater attention. There are certain industries that are
both highly mobile and highly sensitive to local crime rates, for example the tourism sector. As incomes rise, tourism destinations become global, and locations compete against each other. High crime rates are a strong deterrent to tourism [Altindag, 2014]. The explosion of crime in Latin America may have cost the region significant tourism revenues.

We model an industry that can only operate in a low-crime environment, to see how this affects equilibrium.

**Corollary 3: Footloose industries**

Suppose that one of the two industries, called tourism, can only operate if the crime rate is below some threshold \( \bar{q} \). We assume that threshold \( \bar{q} \) is above the autarky crime rate.

(a) Suppose that tourism is relatively more labor-intensive than the other industry. If the difference in factor endowments \( \frac{K_i}{N_i} \) is large enough, tourism will locate exclusively in the labor-rich country. Crime will be higher in the capital-rich country than if both industries could operate in both countries.

(b) Suppose that tourism is relatively more capital-intensive than the other industry. It is possible that no stable equilibrium exists: the tourism industry is perpetually relocating from one country to the other.

**PROOF:** See Appendix 7.7.

The corollary indicates that the existence of mobile industries can aggravate the impacts of crime, and can potentially contribute to instability.

6 Conclusion

Trade flows have surfaced as an important new explanatory variable in the study of crime rates, and of conflict more generally ([Dal Bó and Dal Bó, 2011], [Garfinkel et al., 2015], [Ghosh and Robertson, 2012]). This paper argues that trade flows will be particularly important in explaining how crime rates can reach extreme levels in certain regions of the world. The fact that trade creates a wedge between (1) the returns to wage work and (2) the output per worker produced in a country means that it is an important driver of crime. Crime will thrive in a capital or resource-rich environment, because output per worker is high and therefore the gains from crime are high, but international trade pushes down local wages. This effect can be so powerful that it cancels out the gains to trade for a resource intensive country.

This paper has assumed away the enforcement sector, for simplicity. The next step is to explore how these results would be affected by incorporating an enforcement sector. Some authors have assumed a level of enforcement chosen by a social planner who faces convex enforcement costs.
(e.g. [Ghosh and Robertson, 2012]). In that case, enforcement attenuates the results but does not change the direction of the effects. If, in contrast, enforcement is constrained by how much can be currently raised from the tax base, then there is the potential for multiple equilibria, as shown by [Roland and Verdier, 2003]. With too many criminals, the tax base is small and enforcement is ineffective; but with few criminals, the tax base is large and enforcement is effective. In the extreme, if robbers become the majority, they may vote for less enforcement [Stefanadis, 2010]. Thus the challenges of enforcement create an additional source of large variation in crime rates, which should be explored further.
7 Appendix

7.1 Derivation of Table 1

The derivations in this section are from classical trade theory. Equation 5 (the equalizing of the marginal product of labor and capital across sectors) implies

\[ k_{yi} = \frac{(1 - \alpha)\beta}{\alpha(1 - \beta)} k_{xi} \]  

and

\[ p_i = \frac{(1 - \beta)k_{yi}^\alpha}{(1 - \alpha)k_{xi}^\beta} \]  

and in the presence of trade, there is the further condition that \( p_i = p_j = p \) (prices are equalized) and therefore (from 7 and 8) \( k_{xA} = k_{xB} \) and \( k_{yA} = k_{yB} \).

Therefore, in the presence of trade, using the equation for the total capital stock, \( K_i = k_{xi}L_{xi} + k_{yi}L_{yi} \):

\[ \frac{K_A}{L_{xA} + \frac{(1 - \alpha)\beta}{\alpha(1 - \beta)}L_{yA}} = k_{xA} = k_{xB} = \frac{K_B}{L_{xB} + \frac{(1 - \alpha)\beta}{\alpha(1 - \beta)}L_{yB}} \]  

The remaining equations are from the final consumers. Cobb-Douglas preferences imply that consumers spend a share \( \frac{1}{\gamma + 1} \) of their income on \( X \) goods and the remainder on \( Y \) goods:

- In autarky, the output of goods \( X \) and \( Y \) in country \( i \) reflects those preferences:

\[ \gamma p_i X_i = Y_i \]  

Simplifying with equation (7):

\[ \Rightarrow L_{yi} = \gamma \frac{1 - \beta}{1 - \alpha} L_{xi} \]  

- In the presence of trade, the world price of \( X \) is \( p \), and total output of \( X \) and \( Y \) across the two countries reflects those preferences:

\[ \gamma p(X_A + X_B) = Y_A + Y_B \]  

Simplifying with equation (7):

\[ \Rightarrow L_{yA} + L_{yB} = \gamma \frac{1 - \beta}{1 - \alpha} (L_{xA} + L_{xB}) \]  

Table 1 summarizes that equation (7) applies in autarky, and equation (9) and (13) apply in the case of trade.
7.2 Proof of Proposition 1(b) and 1(c)

As in Table 2, we adopt the notation: \( \theta = \frac{\alpha (1 - \beta)}{1 - \beta}; \sigma = \frac{1 - \beta}{1 - \alpha}; c = \frac{(1 - \beta) n}{n - 1 + s n - \frac{\alpha}{\sigma}}; a = \frac{n - 1 + s n - \frac{\alpha}{\sigma}}{n - 1 + s n - \frac{\alpha}{\sigma}}. \)

Therefore \( 0 < \theta < \sigma < 1, \) and \( \theta < a < 1, \) and \( 0 < c < a < 1. \)

Notice that equation (6) can be rewritten as \( c N_i = a L_{x_i} + L_{y_i}. \)

Proof of Proposition 1b: Based on Table 2, using subscripts “a” and “f” to refer autarky and free trade, note that:

\[
L^a_{x_A} + L^a_{y_A} + L^a_{x_B} + L^a_{y_B} = \frac{c(N_A + N_B)(1 + \gamma \sigma)}{a + \gamma \sigma} = L^f_{x_A} + L^f_{y_A} + L^f_{x_B} + L^f_{y_B}
\]

So there has been no change in the total amount of labor devoted to productive work, and hence no change in the total number of criminals.

We will show that the change in employment in country A after free trade is positive:

\[
L^f_{x_A} + L^f_{y_A} - L^a_{x_A} - L^a_{y_A} = \frac{c(N_B K_A - N_A K_B)}{K_A + K_B} \left( \frac{1 + \gamma \sigma}{a + \gamma \sigma} - \frac{1 - \theta}{a - \theta} \right)
\]

Recall that \( N_B K_A - N_A K_B < 0, \) because B is the capital-rich country. Remains to show that the second bracket is negative. Using the fact that \( \theta < a < 1, \) we show that \( \frac{1 + \gamma \sigma}{a + \gamma \sigma} > \frac{1 - \theta}{a - \theta} \) is a contradiction.

\[
\frac{1 + \gamma \sigma}{a + \gamma \sigma} > \frac{1 - \theta}{a - \theta} \Leftrightarrow (a - 1)(\theta + \gamma \sigma) > 0
\]

which contradicts \( a < 1. \)

Proof of Proposition 1c We begin by considering the parameter values for which only industry Y operates in Country B.

In country A: Both industries operate, so \( N_i = \left( \frac{n - 1 + s n - \frac{\alpha}{\sigma}}{n - n s} \right) L_{x_i} + \left( \frac{n - 1 + s n - \frac{\alpha}{\sigma}}{n - n s} \right) L_{y_i} \) from equation (6), which we rewrite as \( c N_A = a L_{x_A} + L_{y_A}. \)

In country B: Payoff to crime = Wage in Industry Y

\[
sq_{y_B}(n k^\beta_{y_B}) = (1 - sq)(1 - \beta) k^\beta_{y_B}
\]

In this case \( q = 1 - sq = \frac{N_B - L_{x_B}}{N_B - L_{x_B} + L_{y_B}}. \) Solving, the equation becomes \( L_{y_B} = c N_B. \) This is equation (6) with \( L_{x_B} = 0. \)

Recall from the discussion of equation (6) that the larger the labor share of industry Y, the higher the crime rate. Thus crime is even higher in Country B when industry X does not operate. As for Country A, industry X is even larger in country A, and industry Y even smaller, than in the cone of diversification; thus the crime rate is lower. (And if country A also specializes, the crime rate would be even lower.)
7.3 Stability of equilibrium in autarky and with trade

We explore the stability of equilibrium in the following sense: we verify that if the number of criminals is above (below) its equilibrium level, the payoff to crime is below (above) the payoff to wage work. Given that crime does not affect the relative payoff to wage work in industry X and Y, and that the forces allocating workers across sectors are well known, we assume for simplicity that workers are earning the same returns in both industries. We also assume capital earns the same return in both industries.

**In Autarky:** Suppose that wage employment is higher (lower) than equilibrium in Country $i$: $L_{xi} + L_{yi} = cN_i (1 + \gamma \sigma) a + \gamma \sigma + \epsilon_i$, where $\epsilon$ is positive (negative). Equal wages in industries X and Y implies $L_{yi} = \gamma \sigma L_{xi}$ (equation 11).

The payoff to wage work is lower than the payoff to crime if $cN_i < aL_{xi} + L_{yi}$ (see equation 4 and following). We have $aL_{xi} + L_{yi} = cN_i + \epsilon\left(\frac{1 + \gamma \sigma}{a + \gamma \sigma}\right)$. Thus if wage employment is higher (lower) than equilibrium, the payoff to wage work is lower (higher) than the payoff to crime and crime will expand (shrink).

**With Trade:** Let $\epsilon_i$ be the difference between $L_{xi} + L_{yi}$ and its equilibrium value in Table 2; so a positive value means lower-than-equilibrium crime in country $i$.

\[
L_{xi} + L_{yi} = \frac{cK_i}{K_i + K_j} \left[ (N_i + N_j)(1 + \gamma \sigma) \frac{a + \gamma \sigma}{a + \gamma \sigma} + \left( \frac{N_i K_j - N_j K_i}{a - \theta} \right)(1 - \theta) \right] + \epsilon_i
\]

Again, the payoff to wage work is lower than the payoff to crime in Country $i$ if $cN_i < aL_{xi} + L_{yi}$.

Using equations (9) and (13) (which arise from the equalization of returns to labor and capital across industries) and the equilibrium values in Table 2, we obtain:

\[
aL_{xi} + L_{yi} = cN_i + \epsilon_i + (\epsilon_i + \epsilon_j) \left( \frac{K_i(a - 1)}{K_i + K_j} + \frac{(K_j \epsilon_j - K_i \epsilon_j)(a - 1)}{(K_i + K_j)(1 - \theta)} \right)
\]

Therefore we have the following equivalence:

\[
aL_{xi} + L_{yi} > cN_i \Leftrightarrow \epsilon_j > -\epsilon_i \left( 1 + \frac{a - \theta}{1 - a} \left( \frac{K_i + K_j}{K_i} \right) \frac{1 + \gamma \sigma}{\theta + \gamma \sigma} \right)
\]

And then the proof of stability is graphical: the stable equilibrium is $\epsilon_i = \epsilon_j = 0$. The slope of the lines comes from (14),(15), and the fact that $\theta < a < 1$. 
7.4 Proof of Proposition 2

In autarky, country B just consumes its own output.

Per-capita utility in autarky

\[
\text{Per-capita utility in autarky} = \frac{1}{N_B} \left( X_B^{\gamma} + Y_B^{\gamma} \right) = \frac{1}{N_B} \left( k_x^B L_x B k_y^B L_y B \right)^{\frac{1}{\gamma}} = \frac{1}{N_B} \left( k_x^{\alpha + \beta \gamma} \theta^{\gamma \gamma} L_x B L_y^B \right)^{\frac{1}{\gamma}} = \frac{1}{N_B} \left( \left( \frac{K_B}{L_x B + \frac{L_y B}{\theta}} \right)^{\alpha + \beta \gamma} \theta^{\gamma \gamma} L_x B L_y^B \right)^{\frac{1}{\gamma}} = \left( \left( \frac{K_B}{N_B \gamma \sigma} \right)^{\alpha + \beta \gamma} \theta^{\gamma \gamma} (\gamma \sigma)^{\gamma} \right)^{\frac{1}{\gamma}} c^{\frac{1}{a + \gamma \sigma}}
\]

In the presence of trade, country B will consume its share of world output by value, \( \delta = \frac{pX_B + Y_B}{pX_{tot} + Y_{tot}} \). Here we use the fact that \( pX_{tot} = \frac{Y_{tot}}{\gamma} \), from equation (12).
Per-capita utility in the presence of trade

\[
\text{Utility in autarky} > \text{Utility in the presence of trade if and only if } 1 > K_B \left[ \frac{N_A + N_B}{K_A + K_B} \left\{ \frac{(N_A + N_B)}{K_A + K_B} \right\} \left\{ \frac{(N_A + N_B)}{K_A + K_B} \right\} \left\{ \frac{(N_A + N_B)}{K_A + K_B} \right\} \right] \frac{\gamma + \sigma + 1}{\gamma + \sigma + 1}.
\]

Proof of Proposition 2(b): Note that the proposition is always satisfied if \((1 - \theta)(a + \gamma \sigma) > (a - \theta)(1 + \gamma \sigma)\). Replacing \(\theta, a\) and \(\sigma\) with their values, this is equivalent to \(s > \frac{a - 1}{n}\).

7.5 Proof of Proposition 3

Proof of Proposition 3a: We compare employment shares in a world with crime (c) versus a world with no crime (nc). Labor shares in a world with no crime are derived from the equations in Table 1:

\[
L_{yB}^{nc} = \frac{K_i}{K_i + K_j} \left[ \frac{(N_i + N_j)\gamma \sigma}{1 + \gamma \sigma} - \frac{(N_i K_i - N_j)\theta}{1 - \theta} \right]
\]

We adopt a proof by contradiction, using this result and Table 2: Suppose that

\[
\frac{L_{yB}^c}{L_{yA}^c + L_{yB}^c} > \frac{L_{yB}^c}{L_{yA}^c + L_{yB}^c}
\]
\[
\begin{align*}
\iff & \frac{(N_A K_B - N_B K_A) \theta (1 + \gamma \sigma)}{(K_A + K_B)(N_A + N_B)(1 - \theta) \gamma \sigma} > \frac{(N_A K_B - N_B K_A) \theta (a + \gamma \sigma)}{(K_A + K_B)(N_A + N_B)(a - \theta) \gamma \sigma} \\
\iff & \frac{1 + \gamma \sigma}{1 - \theta} > \frac{a + \gamma \sigma}{a - \theta}
\end{align*}
\]
which we showed to be a contradiction in the proof of 1(b).

**Proof of Proposition 3b**: The proof of 1(c) shows that any parameter values for which the solution to \( L_x \) or \( L_y \) in Table 2 is zero or negative are outside the cone of diversification.

Range for which \( L_x \leq 0 \) under no crime (deriving those values from the conditions in Table 1):

\[
N_A + N_B \left( 1 + \gamma \sigma \right) > \frac{N_B K_A - N_A}{1 - \theta} < 0
\]

\[
N_A \frac{N_B}{K_B} > \frac{(1 + \gamma \sigma) K_A}{\theta + \gamma \sigma} + \frac{1 - \theta}{\theta + \gamma \sigma}
\]

Range for which \( L_x \leq 0 \) under crime (using Table 2):

\[
N_A \frac{N_B}{K_B} > \frac{(a + \gamma \sigma) K_A}{\theta + \gamma \sigma} + \frac{a - \theta}{\theta + \gamma \sigma}
\]

Given that \( 0 < a < 1 \), the term on the right-hand side is positive and smaller than under ‘no crime’, so this is wider parameter range. The proof that there is a wider parameter range for which \( L_y = 0 \) follows identical lines.

### 7.6 Proof of Corollary 2b

We demonstrated in the text that wages are lower in the high crime country (when there are no technological differences between countries). Therefore if migration were allowed, workers would migrate from the capital-rich country B to the labor-rich country A, increasing the resource differences between the countries and hence the crime rate in country B. This further increases the difference in wage rates, leading to more migration.

As \( \frac{N_B}{N_A} \) continues to fall, eventually the countries will be outside the cone of diversification, as shown in the proof of Prop. 2b.

It is sufficient to show that as \( \frac{N_B}{N_A} \) continues to fall, wages are continuous, and that eventually the inequality in wages (wages in A > wages in B) is reversed. By the intermediate value principle, there is a level of migration for which wages in the two countries are equal, and no more migration occurs.

Let us show that eventually \( w_B > w_A \) when country A produces only X, and country B produces only Y, if workers continue to migrate towards country A. (Recall from the proof of Proposition 1(c) that \( L_x = \frac{c N_A}{a} \) and \( L_y = c N_B \) in that case.) Recall that \( p = \frac{Y}{X} \), so \( p = \frac{k_{x B} L_{x A}}{k_{y B} L_{y A}} \).
Wages in $B = (1 - q_B s)(1 - \beta)k^\beta_B$

Wages in $A = (1 - q_A s)(1 - \alpha)pk^\alpha_A = (1 - q_A s)(1 - \alpha)k^\beta_B \frac{L_A}{\gamma N_A} = (1 - q_A s)(1 - \alpha)k^\beta_B \frac{N_B}{\gamma N_A}$

Wages are higher in country $B$ if

$$(1 - q_B s)(1 - \beta) > (1 - q_A s)(1 - \alpha)\frac{aN_B}{\gamma N_A}$$

Replacing $q_B$ and $q_A$ with their values in terms of fundamentals:

$$(1 - s \frac{1 - c}{1 - c + \frac{c}{n}})(1 - \beta) > (1 - s \frac{1 - \frac{c}{a}}{1 - \frac{c}{a} + \frac{c}{mn}})(1 - \alpha)\frac{aN_B}{\gamma N_A}$$

this equation will clearly be satisfied as $N_B$ falls towards zero.

7.7 Proof of Corollary 3

Corollary 3(a) follows immediately from Proposition 1. Tourism can operate in both countries in autarky, but if the difference in relative factor endowments is large enough, the crime rate will rise sharply in the capital-rich country when it opens to trade. Trade had already caused much of the tourism industry to relocate to the labor-rich country ($A$), but if the rise in crime is above the threshold $\bar{q}$, tourism will locate exclusively in the labor-rich country. As shown in Proposition 1(c), $cN_B = L_yB$ and crime rates are even higher in the capital-rich country outside the cone of diversification.

Proof of Corollary 3b: Recall from equation (6) that crime rises whenever the size of the capital-intensive industry ($Y$) increases.

If tourism is the capital-intensive industry, then tourism initially expands in the capital-rich country ($B$) with trade. The crime rate rises in $B$. If it rises above $\bar{q}$, the tourism industry will relocate to country $A$. The tourist industry will now be larger in $A$ than in autarky, as it is supplying both countries; thus the crime rate in $A$ will be higher than it was in autarky. It is possible that the crime rate in country $A$ is now higher than $\bar{q}$, for example if $\bar{q}$ is only slightly higher than the value of $q$ in autarky. And if the crime rate in $A$ is above $\bar{q}$, the tourism industry will cycle from one country to the other in perpetuity.
References


