Dutch Disease, Informality, and employment intensity in Colombia

RESEARCH PROPOSAL

Presented to

Partnership for Economic Policy (PEP)

By
Ricardo Argüello

&
Dora Jiménez
Edwin Torres
Mónica Gasca

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SECTION A – For all projects

1. Abstract (100 to 250 words)

The abstract should state the main research question, the context and its relevance in terms of policy issues/needs in relation to PAGE thematic foci, complete with a brief description of the data that will be used.

From the first half of the 2000s the Colombian economy has been under the influence of an oil and mining production and export boom that has triggered the potential for Dutch disease effects. This issue is at the center of important current policy (and political) debates and merits due attention to its potential impacts on several dimensions of the economy. Among these, there is the appraisal of the likely effects of the export boom on the economy at large and on labor market dynamics. As the boom has the potential to induce shifts in the sectoral composition of the economy, it may have significant effects on employment dynamics and on the evolution of the employment intensity of the economy and its productivity, especially when the informal sector is sizable. We aim to study these and other related issues, such as evaluating the policy package put in place by the government to deal with the potential macroeconomic effects of the export boom, and evaluating alternative policy measures, by means of a single country, recursive dynamic computable general equilibrium model (CGE). A 2011 Social Accounting Matrix of the Colombian economy will be built for these purposes, in which activities are differentiated in terms of their formal and informal components, and suitable details are included to isolate accounts belonging to the national oil company and to the implementation of the policy package designed by the Colombian government.

2. Main research questions and contributions

Explain the focus (or key questions) of your research and its policy relevance.

2.1. Explain why you think this is an interesting research question and what the potential value added of your work might be (knowledge gaps). You might want to explain whether or not this question has been addressed before in this context (including key references), and if so, what do you wish to achieve (in addition) by examining the question again?

Our main research questions can be summarized in the following way:
(i) its impact on the evolution of the productive structure, (ii) its impact on the import-intensity of non-boom sectors and its implications for employment dynamics in general, and (iii) its impact on the evolution of the informal sector.

- What is the expected impact of the current and foreseeable production and export boom of the oil and mining sector, on the evolution of the productive structure of the Colombian economy?

- What is the likely time path of these effects in the short and medium run?

- How does the induced change in the economy’s productive structure impact labor demand?

- In particular, how do employment redistributes between the formal and informal sectors and what is the likely evolution of unemployment (i.e. would the oil and mining boom have a positive or negative impact on labor markets)?

- What is the relationship between changes in the import intensity in non-boom sectors, the behavior of employment generation in general, and that of the informal sector?

- What is the potential effect on the labor market of policy measures undertaken by the government for facing the macroeconomic effects of the export boom?

In what follows we discuss the context in which the above listed research questions arise and provide the rationale for understanding their contribution to the current policy debate in Colombia.

Due to the behavior of the international economy, that of Foreign Direct Investment (FDI) incoming to Colombia, and the dynamics of the national oil company (Ecopetrol), it is expected a continuing and significant increase in mineral and oil production and exports in the country. Even though there is discussion on the dimension of this growth, available data indicates that the production increase is imminent as estimated by the Private Competitiveness Council (PCC) based on other sources’ data.\(^1\) According to the 2010-2011 National Competitiveness Report from the PCC, total investment in the oil and mining sector grew 450% between 2001 and 2009 and it was expected to increase around US$62 billion in the following five years. Under these conditions, Colombia would be producing 1.7 million barrels of oil a day in 2018 and 150 million tons of coal in 2019, from less than a

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\(^1\) The issue as to whether the increase in production may be properly qualified as a “boom” was debated by the government in the press at different moments along 2011.
million barrels a day in 2010 and a little more than 90 million tons of coal.

According to data from the Colombian Central Bank, inbound FDI destined to the oil and mining sector has added US$24.6 billion to the investment stock between January 2010 and the second quarter of 2013, without counting investment done by Ecopetrol. From this, it follows that the PCC’s production projections are not off the mark; indeed, according to Colombia’s National Hydrocarbons Agency the current annual average daily oil production in Colombia is slightly above 1 million barrels (50% up from its 2009 mark).

On the other hand, excluding oil products, exports from the oil and mining sector represent a rising share of total Colombian exports. In 1991 their share in total exports was 27%, while in 2013 it was 63%. This increase has gained momentum since 2002 when this share was 34% (less than a 7 point difference with respect to 1991), growing almost 28 percentage points to reach the 63% share registered in 2013. While total exports have grown at an annual compound rate of almost 11% between 1991 and 2011, the oil and mining sector’s exports have increased more than 15% a year. If these trends hold, and given that the oil and mining sector is one of the most dynamic in the economy, its export share is very likely to rise even more (at the current growth rates, sectoral exports would represent more than 75% of total exports by 2020).

Given the above, there is discussion as to whether there is the risk that the economy may suffer from Dutch disease. Casual observation of the behavior of the nominal exchange rate\(^2\) shows that between 1991 and 2003 it continuously increased at an annual compound rate of 13.4% while between 2003 and 2012 it has decreased at an annual rate of 5.1%. In a similar fashion, the real exchange rate index, although with fluctuations, has decreased between March 2003 and December 2012 (a total of 43.1 percentage points; the decrease until October 2013 is 38.1 percentage points).

Analysts from different ideologies have pointed in the press, especially during the last three years, that the economy is already showing symptoms of the Dutch disease.\(^3\) The arguments range from the rapid increase of oil and mineral exports (relative to total exports), to the relatively low growth rates that industry and agriculture have shown in the last years, to the appreciation of the peso, and to the increase in imports that have come along the export boom (all these aggravated by a fiscal deficit, that although lower than two years ago, is still in the order of 2 percentage points of GDP).

In recent months, the discussion have delved around two issues: the relative stagnation of

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\(^1\) Expressed as pesos per UD dollar.

\(^2\) While it is not relevant to reference their opinions, the list includes politicians, former and current senators, university professors, a former finance minister, a former President of the Republic, and at least a member of the Central Bank’s Board of Directors.
manufacturing and the behavior of employment. In effect, while the simple annual average growth rate for the economy was 4.3% between 2003 and 2012, the corresponding to manufacturing was 3.3. Besides growing more slowly than the whole economy, manufacturing decreased 4.1% in 2009 and 0.5% in 2012. On the other hand, until very recently, unemployment kept at relatively high levels in spite of the economy showing dynamism. During the period 2003-2012, the unemployment rate was 11.9% in average with moderate variation (the coefficient of variation calculated on monthly data was 0.13). It is only from May 2013 on that the unemployment rate has started to recede, probably as a consequence of recent fiscal reforms that reduced some surcharges associated with formal labor hiring, reaching levels in the order of 9%. In contrast, informal employment has been high and shows no clear sign of declining, situating around 50% of total employment. During 2007 (a year with a 6.9% growth rate in GDP) informality reached 50.2% of total employment, while during 2009 (a year with a growth rate of 1.6%) it was 52.1%, and during 2013 49.3%.  

On the opposite side, the government claims that although there may be some symptoms of Dutch disease, the economy is still far from suffering its consequences. In May 2012, the Colombian central banker declared to the press that the economy was growing in a balanced manner and that there are no symptoms of Dutch disease. In fact, figures on real annual GDP growth shown by the minister of finance before Congress in November 2011, indicate that tradable (with and without oil and mining) and non-tradable sectors behave in a similar way and that the gap between them is not unusual; furthermore, they imply that annual employment variation is close across these sectors and that the behavior of non-oil and mining exports is relatively dynamic.

Given the salience and importance of this discussion, it is interesting that, to the best of our knowledge, there are basically no recent research outcomes on the topic in Colombia, that may help guide it and which can inform policy discussion in a meaningful way. While it may not be of interest trying to establish whether or not the economy may be qualified as suffering from Dutch disease, what is surely relevant for policy making in different areas is to be able to count on sound research results about the potential effects of the expected increase in oil and mining production and exports on the rest of the economy and on the labor market. In the particular case at hand, we are interested in three dimensions of the

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4 The figures correspond to a definition of informality according to occupational position and social security coverage.

5 However, in August 2011, the Colombian president declared, at a meeting at the UN's ECLAC, that the Colombian economy was getting close to suffer from the Dutch disease.

6 At least no research outcomes that are publicly available. Ex post research on previous episodes of potential Dutch disease, especially linked to “coffee export booms” during the 1970s and oil booms during the 1980s and 1990s are relatively common. An exception to this is the work of Rojas and Forero (2011), on which we comment later.
potential effects of this exports boom: (i) its impact on the evolution of the productive structure, (ii) its impact on the import-intensity of non-boom sectors and its implications for employment dynamics in general, and (iii) its impact on the evolution of the informal sector.

As for the first issue, the stylized facts on Dutch disease economics indicate that there is the likelihood for a boom-and-bust cycle arising either from the behavior of international prices or from resource exhaustion. With respect to the second issue, foreign exchange rate appreciation originated in the export boom may lead not only to a decline in exports from sectors different from, in this case, oil and mining, but also to a decline in production of import-competing sectors and of non-boom export sectors, and also to higher prices for non-tradables (depending on other conditions).

The third issue arises from the same logic. As “de-industrialization” may settle as a consequence of Dutch disease mechanisms, the dynamics of formal employment generation may not only decrease (given the oil and mining sectors in expansion are highly capital intensive and have, in general, scant linkages with the rest of the economy), but be affected by a bias toward more skilled workers. This could be the result of the combined effect of the type of worker that the expanding sector needs, of increased import-intensity in non-agricultural, non-oil and mining sectors, and of potentially increased informality. The latter depending upon the share that informality has in the two types of activities and on tradability of its production.

Dutch disease economics has received broad attention in the literature. It has been associated to significant medium term income increases arising from an export boom or enhanced foreign capital inflows, including remittances, international aid, and foreign direct investment. The classic treatment of the subject in Corden and Neary (1982) distinguishes two effects: a spending effect and a resource movement effect. The first occurs as a result of the increased real income accruing from the boom, which, provided tradable and non-tradable goods are not inferior, translates in greater demand for both. Short run effects from this increase in demand, lead to higher prices for non-tradables and larger imports, and a change in relative prices of non-tradables with respect to tradables, implying appreciation of the real exchange rate (which in turn negatively impinges upon the competitiveness of non-boom export sectors).

Higher prices in the non-tradables sector and increased activity in the boom sector, induces reallocation of resources from the rest of the economy. This reallocation has general equilibrium effects that are not obvious and depend mainly on consumer behavior and factor mobility.

In its analysis of one of the several coffee booms of the Colombian economy, Edwards
(1985) found that higher coffee prices led to an increase in reserves and to a higher rate of money supply. As a consequence, the inflation rate increased and the dynamics of the nominal exchange rate led to real exchange rate appreciation and loss of competitiveness for tradables other than coffee. If, under these circumstances, the government increases its deficit and finances it (even partially) with foreign borrowing, pressure on the real exchange rate increases and a magnification effect ensues. As pointed out by the Colombian Ministry of Finance (2011), the Colombian experience in the management of export booms has not been very fortunate and the economy has experienced growth deceleration in the aftermath of these booms.

There is robust evidence that increases in the terms of trade lead to a real exchange rate appreciation in countries rich in natural resources, as illustrated for example in Spatafora and Warner (1995). In contrast, evidence on a deindustrialization process seems to be less conclusive. For instance, Sala-i-Martin and Subramanian (2003) finds no clear cut effects in this direction, while Ismail (2010) claims that a 10% increase in oil income produces an average 3.4% drop in industrial value added. Also, deindustrialization tends to be higher in economies that are more open to capital flows and have less capital intensive manufacturing sectors.

As happens with deindustrialization, evidence on the long term consequences of the Dutch disease is blurred. Sachs and Warner (2001) argues that natural resources abundance has a strong negative effect on economic growth, leading to the infamous “curse of natural resources”. Lederman and Maloney (2008) founds a positive effect of natural resources abundance on long term growth. Collier and Goderis (2007), using panel data, tries to reconcile these opposite views; it concludes that price booms have a short term positive impact on growth and that economies with poor governance and natural resource enclaves (like oil and mining) show significantly negative long term growth effects. Treviño (2011) uses a heuristic approach for appraising the CEMAC region economies, finding that in the oil rich ones there is indeed real exchange rate appreciation and factor reallocation but that there is no evidence of a resource curse as oil abundance does not seem correlated with long term performance. Magud and Sosa (2010) argues that there is no mechanism in the literature by which Dutch disease reduces long term growth.

Consistent with the above discussion, we take the view (with Magud and Sousa, 2010) that, from a policy making point of view what is perhaps more relevant is to determine if the appreciation is driven by a permanent (structural) change and then steer the economy away from overshooting, overheating, and the rise of macro imbalances that may prove unsustainable. However, determining whether or not the economy is facing a permanent change is a daunting task and mistakes could be costly. In any case, the short and medium run effects of real exchange rate appreciation, where a host of potentially undesirable consequences of Dutch disease economics concentrate, should be assessed
and hopefully addressed. While the research activity we propose cannot help in determining the nature of the shock behind the Dutch disease, it can certainly contribute to the appraisal of its consequences on the three fronts mentioned above and to usefully inform policy making in the corresponding dimensions.

As mentioned, there is only one piece of work that we are aware of (and is publicly available) that investigates the potential effects of Dutch disease in Colombia and may be useful for appraising its effects on the real economy. The reference is to Rojas and Forero (2011) which examines the macroeconomic impact of an oil boom on the Colombian economy and, among other issues, explores alternative scenarios for facing the boom. The paper uses a recursive dynamic CGE model to simulate four scenarios: (i) short run consumption of income from the boom, (ii) establishment of an external fund, (iii) investment in infrastructure, and (iv) phase off of distorting taxes (the boom’s income substituting for lost fiscal revenue). As follows, the focus of this work differs markedly from ours. While it explores best courses of action for the government for using the revenue windfall, with growth as the leitmotif of intervention, our work centers around the potential impact of the boom and policies tailored to manage it on labor market dynamics in the sense depicted above.

Aside from this work, the PCC’s report cited above is based upon production projections data from the Ministry of Mining and Energy and two studies; one by the National Manufacturers Association (ANDI by its Spanish acronym) and one by a local think tank (Fedesarrollo; Cardenas and Reina, 2008). The former, ANDI (2009), centers on backward and forward linkages for the oil sector with a view to quantifying supply and demand of goods and services along the sector’s value chain. The latter, Cardenas and Reina (2008), inquires around the socio-economic and fiscal impact of the mining sector. As for the socio-economic consequences of mining, the study basically estimates an econometric model to determine if regional economic growth is related to the mining activity and concludes that the latter has a positive impact. It also provides estimates for 2005 on direct backward and forward linkages for the sector, based on national accounts and an estimate of direct and indirect linkages based on an applied static general equilibrium model. On the fiscal front, the paper essentially quantifies the contribution of the mining sector to fiscal income through its main channels.

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7 We thank the referee of this proposal for pointing us to this document.
8 There is also the work of Nuñez and Gonzalez (2011), that uses the MACEPES model for assessing vulnerabilities of the Colombian economy (among them to terms of trade changes and rises in oil prices). However, its aim is different from the focus we have here.
9 The study was made by Fedesarrollo under contract for ANDI.
10 Results from the model show that the services sector is the major beneficiary of output expansion in the mining sector and that indirect effects are significant in attaining it through additional demand for non-tradables. No further detail on the results is provided since its use is confined to quantifying production linkages.
Perilla (2009, 2010) performs an econometric analysis on the relationship between international oil prices and economic growth, both in general and at the sectoral level. It finds that oil prices have a positive effect on economic growth although in an asymmetrical manner: while a positive change in prices leads to no significant growth changes, a price decline do have a negative impact. At the sectoral level the study finds effects akin to a Dutch disease situation; output declines in industry and agriculture and increases in non-tradables, especially construction.

The Colombian Ministry of Finance and Public Credit (2010) provides an overview of the foreseeable future of oil and mining production and of its expected impact on governmental finance. However, the forecasts are limited to the macroeconomic impact of this production with a view to support the proposal of several measures aimed at managing the effects from the export boom.

2.2. Describe the specific policy issues/needs that your research aims to address; how your potential outcomes/findings may be used in policy making?

• Justify timing of your research in terms of policy and socioeconomic needs/context – e.g. reference to existing/planned/potential policies at the national level.
• Evidence of previous consultation with potential users (e.g. policymakers and key stakeholders) to help define your research question is strongly encouraged. Include a list of names, institutions and email addresses when possible.

From the above, there are several facts that are worth pointing. First, there is evidence of appreciation of the Colombian real exchange rate and an intense national discussion with respect to potential Dutch disease effects. Second, all available oil and mining production forecasts point to a short to medium run windfall. Third, informal employment is prevalent in the Colombian economy and shows no signs of reduction. Fourth, the government has introduced legislation aimed at managing the income accruing from this windfall. Fifth, beyond the discussion about whether or not it is correct to characterize the current economic situation as one of Dutch disease, it is clear that some of the traditional effects stemming from Dutch disease economics are or will be affecting the Colombian economy. Sixth, to the best of our knowledge, there are no studies that provide estimates of the potential effects of this income boom on labor market dynamics, including employment growth, changes in the structure of employment, labor mobility between the formal and informal sectors, and wages.

The aim of this research is to fill this gap and provide information that is valuable from a

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11 A horizon from 8 to fifteen or more years, depending on the behavior of new oil discoveries.
policy perspective in the dimensions that will be discussed below. Even though, from a methodological perspective the contribution of this research may seem modest (although it uses state of the art techniques), its contribution in terms of policy relevance and timing is highly valuable.

As mentioned before, there are three dimensions of the potential Dutch disease like effects that we are particularly interested in exploring: (i) its impact on the evolution of the productive structure, (ii) its impact on the import-intensity of non-boom sectors and its implications for employment dynamics in general, and (iii) its impact on the informal sector. In what follows we expand on the last two issues.

With respect to the potential impact of Dutch disease on the import-intensity of non-boom sectors and its implications for employment dynamics in general, we have that with the appreciation of the real exchange rate, non-boom sectors tend to be affected according to their trade position. Non-boom tradable sectors are expected to be negatively affected; in the case of exportables due to erosion of their competitive position as the domestic currency appreciates, and in the case of importables due to increased competition as international prices become lower in terms of domestic currency.

On the contrary, non-boom non-tradable sectors are expected to be positively affected, as higher national income translates in increased demand for them and their prices increase. In the medium run, both the boom sector and the non-tradables sector should increase production at the expense of the rest of the economy as relative prices favor them. This translates in changes in employment levels according to the easiness of factor mobility, relative labor intensiveness across activities, potential adjustments in technology use, and, in this case, the cross effect between formal and informal activities within each sector. As services sectors tend to be non-tradable and some of them concentrate a large portion of informal employment, it is likely that the boom will foster informality.12 Therefore, exploring policy options for steering the behavior of the labor market while keeping consistency with the goal of sustained growth is highly relevant.

As follows from the 2005 Social Accounting Matrix (SAM) used in Argüello (2010), the sectoral capital labor ratios of the Colombian economy range from 6.6 (coal) to 0.005 (other agricultural products) and those of activities readily classified as non-tradable range from 4.4 (water and garbage collection services) to 0.03 (land transport services). The ratios corresponding to the oil and mining sector comprise the already mentioned for coal, oil and natural gas (5.4), metallic minerals (0.5), and other non-metallic minerals (0.2). As the appreciation of the domestic currency makes it cheaper to import final goods and

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12 Along 2013, 60% of informal employment concentrated in the commerce, hotels, and restaurants sector (43%), and in the social and personal services sector (17%).
intermediates, import intensity in the economy and especially in the non-boom tradable sector, increases, shrinking employment.

Therefore, estimation of the impact of Dutch disease economics on employment is not straightforward, especially if it is taken into account that activities decompose in formal and informal sub-activities (presumably with different capital labor ratios). This is an undeniably important topic for policymaking in this context and this research aims at providing useful information in this regard.\(^\text{13}\)

With respect to the effects on the informal sector, it is useful to provide some statistics that help capture the issue at hand. According to a World Bank (2010) study, informality in Colombia is high and persistent. About 74% of Colombian workers in 2008 did not contribute to health insurance and pension systems and even during the 2001-2007 high growth period of the economy, the share of workers in the informal sector remained high. Informality in 2006, defined as non-contributing to health and pension systems, affected almost 57% of employees, 96% of self-employed people, and 90% of employers.

From a sectoral perspective, Cardenas and Rozo (2009) find that the probability that a firm is informal, taking as a reference retail trade, is higher in the garbage collection, wood products, textiles, education, and furniture sectors. In a more general fashion, the PCC’s 2011-2012 report (PCC, 2011) estimates that the higher levels of informality, measured as percentage of informal workers, are found in the commerce, hotels, and restaurants sector (69.3%), construction (62.5%), and transport, storage, and communications (61.8%), all of them in the non-tradables sector. As the national average reaches 51.6%, the sectors that follow immediately below are agriculture (48.5%) and manufacturing (42%), two of the sectors traditionally hit by Dutch disease, while the oil and mining sector shows an informality level of 13.9%, the third lowest in the whole economy.

As informality tends to concentrate in the non-tradables sector, we can expect the informal sector to boost if the formal part of the non-tradables sector does not absorb (and formalize) informal workers in an accelerated manner, so that it not only hires workers expelled from the non-boom tradable sector but also informal workers from the non-tradables sector. Therefore, the likely effect of Dutch disease economics on the informal sector is mainly an empirical question. From a policy perspective it is clearly relevant to know if the informal sector is bound to further increase in size (i.e. number of workers), what is the likely behavior of income generation within the sector, and how it translates into households’ income.

\(^\text{13}\) Additionally, there is the issue of net employment generation as, as mentioned, the economy has sustained relatively high unemployment levels (around 12% between 2004 and 2012) that have been resilient to growth spurs (between 2004 and 2007 the simple average annual growth rate reached 5.9% while unemployment was 12.2% on average).
As discussed in the section on methodology, we plan to use a recursive dynamic computable general equilibrium model to run three types of simulations. In the first, we build the baseline scenarios, that is, we trace the expected behavior of the economy, arising from projected oil and mining production and international prices behavior. In the second, we include a set of policy instruments that the government has recently put in place, as briefly described in the methodology section. In the third we include a set of spending plans as suggested by recent literature for ameliorating the negative effects of export booms (as reviewed and applied in Go et al; 2013).

Results from the simulations will contribute, first, to shed light on the likely impact of the boom and policy alternatives on labor market dynamics, providing a time path for its evolution at the national and sectoral levels along a 15 year time span. As far as we understand, this is a unique contribution of this research.

Second, we will provide an ex ante assessment of the expected impact of policy instruments put in place by the government during 2011 for managing the income boom, which, again, is a unique contribution of this research to the policy discussion. In the same vein, we will explore alternative policy measures, providing a contrast of likely outcomes to those attained under the adopted policy.

Third, as the impact of the income boom is likely to point in the direction discussed above, we will provide an explicit consideration of the effects of the dynamics of the economy on the informal sector.

Lastly, given the income boom is expected to have an impact not only on the share of informal employment but also, by increasing import-intensity in non-boom tradable sectors, on employment generation in general, we also focus our attention to the behavior of the dynamics of employment levels in general and by labor types. This way we can inform the policy making process on this important, and currently neglected, topic.

For defining the reach and scope of this research, and for identifying potential interest from different parties on its results, several consultations were made. Reference to them is made in the section corresponding to the Policy Influence Plan.

3. **Methodology**

Presentation of the specific techniques that will be used to answer the research questions and how exactly they will be used to do so. Explain whether you will use a particular technique normally used

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14 The work of Rojas and Forero (2011) was done at a date previous to the issuing of the policy package.
There is an important tradition in the use of applied general equilibrium models for the analysis of Dutch disease in developing economies. Devarajan (1988) surveys applications in this area with an emphasis on theory and model structure. Recent applications include those in Djiofack and Ombga (2011), Aishehabi (2012), Liu and Yang (2010), and McKissak et al (2008), to name a few. The contributions of Dixon et al (2010), Go et al (2013), and Cicowiez and Sanchez (2011) are of particular relevance for us. CGEs are particularly well suited for this type of analysis since they have the capacity of taking into account second round effects of the external shocks on the economy, and to provide sectoral and other detail useful for policy making. We stick to this tradition since this methodological approach is, to our judgment, the best suited for our purposes.

For attaining the proposed objectives we will make use of a recursive dynamic applied general equilibrium model. In particular, we will use the single country, recursive dynamic version of the Partnership for Economic Policy (PEP) model, fully documented in Decaluwe et al (2012). The model extends to multiple periods the single-period PEP-1-1 model, through linking successive periods by means of variables that are inherited from the previous one and are transmitted by a set of “dynamic equations”. The model belongs to the neoclassical tradition, in a perfect competition setting, and agents’ behavior is drawn from optimization problems. Since, as mentioned, the model has a thorough documentation, we do not expand here in describing it. Instead, we focus on a series of modifications that are needed to achieve our objectives.

The first adjustment to the model takes into account the existence of a formal and of an informal sector. As will be mentioned with respect to the data requirements to carry out the project, activities are split between formal and informal. While the basic layout of their production function is similar, they differ in two main respects: (i) informal activities produce only for the domestic market, and (ii) informal activities do not pay taxes. Figures 1 and 2 illustrate, respectively, the nested production structure of the formal and informal activities, as well as their corresponding supply structures.
Given the structure of supply, the implied structure from the demand side assumes imperfect substitution between products produced by formal and informal activities. While informal products come only from domestic (informal) activities, formal products come from domestic formal activities and from the Rest of the World, once again as imperfect substitutes. Imported and exported products are assumed formal; i.e. there is no international trade of informal products. Therefore, both, formal and informal activities, demand composite goods for intermediate consumption and this composition is made up of formal domestic and imported products, on one side, and of informal products, on the other. Figure 3 illustrates this demand structure.
Figure 2. Production and supply structure of informal activities

The second modification has to do with the labor market. As follows from the production structures depicted above, we assume the labor market is segmented in a formal and an informal sector. However, the distinction between formality and informality has nothing to do with the intrinsic characteristics of workers, in the sense that there are both skilled and unskilled workers in the two segments and what determines their formal or informal character is simply the type of activity that hires them.

For modeling this labor market structure we follow Cicowiez and Sanchez (2011) that splits the labor market in two segments: formal and informal. While equilibrium in the formal segment is attained through equalization of demand for formal employment and its supply (after deducting labor mobility to the informal sector and unemployment), in the informal segment it is achieved through equalization of demand and total supply (i.e.
Mobility between the two segments follows a Harris and Todaro (1970) mechanism: mobility stops when the informal wage "equates" the expected wage in the formal sector. Lastly, there is unemployment in the formal segment with real wage downward rigidity, and full employment in the informal segment, under fully adjustable wages. However, there is the possibility that market clearing in the formal segment is achieved through wages. In this case, the unemployment level in the formal segment hits its (calibrated) minimum, labor supply becomes perfectly inelastic, and wages clear the market (in which case there is no labor mobility between the formal and informal segments). This is achieved by using a complementary-slackness condition.

Figure 3. Demand structure

The structure depicted above can be summarized with the following equations (where the time subscript is omitted for simplicity):

\[ QLFS_t = \sum_i QLFE_{i,t} \]
\[
QLIS_i = \sum_l QLIE_{i,l}
\]
\[
(QLFS_i - QLM_i)(1 - FUR_i) = \sum_{j \in i} QLFD_{i,j}
\]
\[
QLIS_i + QLM_i = \sum_{j \in i} QLID_{i,j}
\]
\[
QLM_i = \zeta_i \left( \frac{wI_i}{wF_i(1 - FUR_i)} \right)^\psi_i
\]
\[
wFREAL_i = \frac{WF_i}{CPI}
\]
\[
wFRMIN_i = \frac{wfrmO_i}{QPCR} \left( \frac{QPCR}{QPCR_0} \right)^{wfpqc_i} \left( \frac{1 - FUR_i}{1 - FUR_0_i} \right)^{wffur_i} \left( \frac{CPI}{CPI_0} \right)^{wfcpi_i}
\]
\[
wFREAL_i \geq wFRMIN_i
\]
\[
FUR_i \geq furmin_i
\]
\[
(wFREAL_i - wFRMIN_i)(FUR_i - furmin_i) = 0
\]

Where:

\(QLFE_{i,l}\): endowment of formal labor type \(l\) by institution \(i\)
\(QLFS_i\): quantity supplied of formal labor type \(i\)
\(QLIE_{i,l}\): endowment of informal labor type \(l\) by institution \(i\)
\(QLIS_i\): quantity supplied of informal labor type \(i\)
\(QLM_i\): quantity of formal labor type \(l\) mobilized to the informal segment
\(FUR_i\): unemployment rate for formal labor type \(l\)
\(FURO_i\): initial unemployment rate for formal labor type \(l\)
\(QLID_{i,j}\): quantity demanded of informal labor type \(l\)
\(QLFD_{i,j}\): quantity demanded of formal labor type \(l\)
\(wI_i\): informal wage rate for labor type \(l\)
\(wF_i\): formal wage rate for labor type \(l\)
\(wFREAL_i\): real wage rate for formal labor type \(l\)
\(CPI\): consumer price index
\(CPI_0\): initial consumer price index
\(wFRMIN_i\): minimum real formal wage rate for labor type \(l\)
\(wfrmO_i\): initial minimum real formal wage rate for labor type \(l\)
\(QPCR\): real per capita consumption by households
\(QPCR_0\): initial real per capita consumption by households
\(furmin_i\): minimum unemployment rate for formal labor type \(l\)
\(\zeta_i\): scale factor for labor mobility for labor type \(l\)
\(\psi_i\): elasticity of labor mobility
\(wfpqc_i\): elasticity of real minimum wage rate to per capita consumption
Aside from this, the model will require several, mostly accounting, modifications to fit our needs. Among them it is worth mentioning the following:

- Accounting for rents to natural resources (royalties from oil and mining production), which is one of the key pieces of information needed for analyzing Dutch disease as they increase government income.

- Accounting for the resource flow linked to the national oil company, which is also key for appraising central government income from the oil and gas sector.

- Taking into account the effect of the newly introduced (2012) General Royalties System (SGR, for its Spanish language acronym), which creates the Savings and Stabilization Fund (FAE, for its Spanish language acronym), administered by the Central Bank and projected to withhold an average of 24% of total SGR’s revenues flow between 2013 and 2022. On the other hand, 5% of total SGR revenue is devoted to system administration and support, while the remaining 71% of revenues goes to departmental (state) and local governments (for investment and social spending), the science and technology fund, and to pension payments at the regional level.

- Accounting for the implementation of the newly established law for achieving fiscal sustainability, which comprises the use of a fiscal rule aimed at putting a ceiling on governmental indebtedness. The fiscal rule provides for the establishment of specific targets on the central government’s balance, so as to ensure that its expenses are in line with its long run income. The set of fiscal deficit levels allowed for by the rule apply to the central government, establishing a 2020 fiscal deficit goal of a 1% or less of GDP, as well as intermediate goals for 2014 and 2018 (2.3% or less and 1.9% or less of GDP, respectively).\(^\text{15}\)

- Accounting for the particular characteristics of the oil and mining sectors in at least two directions. First, the fact that oil and minerals production is largely dictated by production policies determined to a great extent outside of the

\[^{15}\] While the law creating the fiscal rule (Law 1473 of 2011) provides for the establishment of a Saving, Fiscal, and Macroeconomic Stabilization Fund, this is different from the fund referred to previously in the context of the SGR. In this case, the fund is fed using income sources belonging to the central government and does not include income from royalties. However, in the design of the fiscal rule it is taken into account that governmental expenses comprise a structural and a counter-cyclical component and that the second has to be influenced by business cycle adjustments and by extraordinary and transitory effects from activity in the oil and mining sector.
domestic economy -as in the case of multinational firms or due to the existence of contracts for future delivery. Also, production depends on the exploration, resource discovery, and establishment of extraction and transport facilities cycle, that may not have a short term link to price behavior. Second, the presence of domestic regulations in the oil sector aimed at two objectives: (i) that domestic sales of crude oil can only be used for refining, and (ii) that domestic demand for refining should be satisfied with preference over exports. In line with the first characteristic, we propose modeling crude oil and mining extraction (production) as exogenous; i.e. production levels will be determined according to production forecasts developed by local authorities.\textsuperscript{16, 17} With respect to the second characteristic, we propose the following modeling approach:

i. crude oil is used for intermediate consumption only by the refining sector;
ii. demand for crude oil is entirely satisfied by domestic production;
iii. crude oil supply to the domestic market exactly matches demand for intermediate consumption from the refining sector at a given a price;
iv. the price paid for crude oil by the refining sector is defined as a function of the international price;
v. exports of crude oil are given by residual production, once domestic demand is subtracted;
vi. international demand for crude oil is perfectly elastic.\textsuperscript{18}

- Inclusion of the fiscal rule, the Stabilization and Saving Fund, and of the unemployment rate, in the dynamic equations.

Lastly, three broad sets of simulations will be run. One corresponding to the baseline, tracing the behavior of the economy along a 15 year-span, in which a suitable oil production and exports scenario will be implemented, based on "standard" production and international price forecasts. Second, a simulation in which governmental policies will be added to the baseline. In particular, we will consider the effects of the new SGR, the implementation of the FAE and the fiscal rule. This will take care of macro policies recently implemented and devoted to aid in preventing potential Dutch Disease effects on the economy and for achieving macro stability in the long run (helping to control for exchange rate appreciation). However, although potentially having indirect effects on

\textsuperscript{16} In particular the forecasts prepared by the National Hydrocarbons Authority (ANH, by its Spanish language acronym) and the Mining and Energy Planning Unit (UPME, buy its Spanish language acronym). We have recently established contact with the latter for these purposes and foresee a close collaboration with them for the development of the research.

\textsuperscript{17} A similar modeling approach was followed by Rojas and Forero (2011).

\textsuperscript{18} The first two characteristics reflect the reality of these markets and are consistent with the corresponding flows in the SAM; the fourth characteristic comes from domestic regulations (as the government fixes this price according to a formula based on the international price of crude oil).
informal sector dynamics, these policies are not aimed at having an impact on it. Being the focus of our work, the third type of simulation examines alternative policy interventions targeted to the informal sector; in particular, it aims at identifying suitable policy instruments for keeping the informal sector from increasing its size or for reducing it, as well as for helping reduce the gap between the formal and informal sectors.

4. Data requirements and sources

This is a critical part of the proposal. The key issue is to explain the reason for the use of the particular data. You must establish that they are ideal for the question you wish to address. Please consult the “Guide for designing a research project proposals” for more detail.

As follows from above, we need to construct a SAM with due detail of the informal sector, operation of the national oil company, and fiscal income arising from oil and mining royalties. Recently, the Colombian National Planning Department, Cespedes (2011), developed a SAM with some of these characteristics for 2007. However, this SAM uses national accounts with base year 2000 and currently we have national accounts available for 2011 using 2005 as base year (which provide a more recent estimation of input-output coefficients, among other advantages). Given the importance of counting on recent data, especially for oil and mining production, as a base for estimating the effects of this activity during a time span of about 15 years, we aim to construct a 2011 SAM similar to that documented in Cespedes (2011), tailored to our purposes.

Among the main aspects to take care about in building the SAM, it is worth mentioning:

- The need to split oil and mining royalties from the account “rents on land and subsoil assets”, a feature that is not considered in Cespedes (2011).

- The inclusion of the national oil company as an agent in the SAM.

- The division of activities between formal and informal sub-activities, which is a relevant distinction in this context given that it is already established, Cespedes (2011), that they imply different technologies (i.e., they have different input-output coefficients and structure of value added).

- The definition of informality at the activity level follows the one adopted by ILO.

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19 As far as we know, there have been no applications using this SAM.
20 We refer to subactivities to signify that, in principle, the formal and informal parts of an activity produce the exact same good. This feature of the SAM is to be evaluated during its construction.
(1993). Therefore, the informal sector comprises informal own-account enterprises and enterprises of informal employers; definitions that help in identifying the right statistics to be used for building the SAM, as informal own-account enterprises are readily identifiable using household surveys, while enterprises of informal employers require additional information (more on this issue below).

- In Cespedes (2011), it is considered that an activity is formal if more than 80% of workers belonging to it are formal. While this seems a sensible choice, we will subject this definition to further scrutiny as the relative size of the activity may be of importance for our purposes (given its impact on the size of the informal sector).

- With respect to intermediate consumption for informal activities, Cespedes (2011) based its estimate in the 1-2-3 Survey. The second phase of the survey was undertaken in 2001 and provides information on the topic for firms in the commerce, manufacturing, and services sectors. While there is another survey focusing on firms with less than 11 workers,\(^{21}\) that is carried out annually, it only provides data for the aggregate of intermediate consumption. Given this, we will have to rely also on the 1-2-3 survey and use information from the other survey for checking data.\(^{22}\)

- The assignment of mixed income among production factors, a procedure that is especially critical for estimating factor compensation in the informal sector. A matching methodology is employed in Cespedes (2011), and will very likely be the one we use.

- The definition of labor types. While Cespedes (2011) generates four labor types according to skill level and age of the worker, we will use different criteria for building our labor types. To begin with, Cespedes (2011) defines a skilled worker as someone with more than high school education, which is likely to be too strict a definition; therefore we will also include in this category workers with technical formation. On the other hand, classification according to age seems problematic to us and we will not consider this as a classifying criterion, instead we intent to introduce the distinction between rural and urban workers, which is important for the analysis of labor markets (among other analytical dimensions).

- The sourcing of households’ income, as it comes from capital income, and labor income in both the formal and informal segments of the labor market. A schematic representation of these flows is provided in the table below:

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\(^{21}\) The micro-establishments survey carried out by the Colombian National Statistical Department (DANE).

\(^{22}\) Methodologically, there are several alternatives for estimating these coefficients, as presented in CEPAL (2010).
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Where:

$A_{j}^{T} =$ activity $j$ of type $T$; $j = 1, ..., N$; $T = \text{Formal, Informal}$.

$L_{l}^{T}$ = labor of type $l$, employed by activity of type $T$; $l = \text{skilled, unskilled}$, $T = \text{Formal, Informal}$.

$k =$ capital

$hhd_{h} =$ type $h$ household.

$X =$ denotes the presence of a flow.

The basic information we will be using for building the SAM is the following:

- Integrated accounts from the national accounts, 2011
- Supply and use tables from the national accounts, 2011
- Integrated Household survey, 2009-2011
5. **Policy influence plan (or research communication strategy)**

- Identify potential users of your research findings, including policymakers and other key stakeholders. Provide a list of institutions and, whenever possible, specific individuals to be targeted for effective policy influence. Please also indicate whether you have already made contacts within the institution.
- How, in the elaboration and execution of your project (from design to dissemination), will you consult/communicate with these users to both gather their inputs and keep them informed of your project (expected contributions and uses), in order to increase chances of your findings to be taken-up into policymaking?

You can refer to **PEP’s research communications strategy and guidance** to have a better idea of what is expected in terms of activities for policy outreach and dissemination.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Contact</th>
<th>Target</th>
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</thead>
<tbody>
<tr>
<td>National Planning Department’s Economic Studies Directorate</td>
<td>Gabriel Piraquive</td>
<td>This is a highly valuable target per se, as the Department acts as a think tank for other governmental agencies. It also is a potential link to the Ministry of Finance.</td>
</tr>
<tr>
<td>National Planning Department’s Sectoral Studies and Regulation Subdirectorate</td>
<td>Gustavo Hernandez</td>
<td>Already contacted. Channel for getting to the higher levels of the Department.</td>
</tr>
<tr>
<td>Ministry of Agriculture’s Sectoral Policy Directorate</td>
<td>Maria Botiva</td>
<td>Already contacted. The ministry has an interest in following up the impact of the income boom on the agricultural sector’s exports and imports.</td>
</tr>
<tr>
<td>Mining and Energy Planning Unit (UPME); Director</td>
<td>Angela Cadena</td>
<td>Already contacted. The UPME is a</td>
</tr>
</tbody>
</table>
As mentioned, a consultation process was carried out for defining the objectives and limiting the scope of this research proposal. We discussed the topic with several people at different levels, including both the public and private sectors. The most relevant were listed in the table above and in all cases they have shown interest in keeping track of the development of the research, as well as, in some cases, to help in providing data or supporting us in obtaining it.

In the particular case of the National Association for Foreign Trade (ANALDEX), we explored the possibility of building a joint Observatory on International Economics, one of whose first major products could be this project. One of the activities planned in the framework of the observatory, is a periodic seminar on topics related to international economics with an emphasis on issues of relevance for Colombian trade policy. This seminar could be one of the outlets for socializing and discussing the results from this research. We also aim at presenting and discussing them in several seminars in Colombian universities and institutions, as well as in meetings with governmental and private sector officials to be held at our university.

6. List of team members

Indicating their age (or whether they are under 30), sex, as well as relevant/prior training and experience in the issues and research techniques involved (start with lead researcher). Note that PEP favors gender-balanced teams, composed of one senior (or experienced) researcher supervising a group of junior researchers, including at least 50% female researchers contributing substantively to the research project. PEP also seeks gender balance in team leaders and thus
positively encourages female-led research teams. (Each listed member must post an up-to-date CV in their profile on the PEP website – refer to "How to submit a proposal")

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Sex (M,F)</th>
<th>Training and experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ricardo Argüello</td>
<td>56</td>
<td>M</td>
<td>PhD from Cornell University with previous experience carrying out PEP projects involving the use of applied general equilibrium models and microsimulation techniques.</td>
</tr>
<tr>
<td>Dora Jiménez</td>
<td>40</td>
<td>F</td>
<td>Doctoral student at the Universidad del Rosario with an interest in trade and international economics issues. Dora has previous experience in data analysis and in conducting economic research on international economics using econometric techniques.</td>
</tr>
<tr>
<td>Edwin Torres</td>
<td>23</td>
<td>M</td>
<td>Edwin is a student in the Master of Economics Program at Universidad del Rosario. He has some research experience as a young researcher at the Universidad del Rosario’s Faculty of Economics, the macroeconomics research group at Universidad de Antioquia and as intern at the Medellin’s regional branch of the Colombian Central Bank (whose research area devolves around labor markets).</td>
</tr>
<tr>
<td>Mónica Gasca</td>
<td></td>
<td>F</td>
<td>Mónica is a double major undergraduate student (Economics and Finance) at the Faculty of Economics at Universidad del Rosario. She has been a teaching assistant in a trade theory course and has some research experience in the field of agricultural investment. Working in this project will provide her valuable experience and will allow her to fulfill part of the requirements for graduation (and transitioning to the master program).</td>
</tr>
</tbody>
</table>

7. **Expected capacity building**

Description of the research capacities that team members (and potentially their affiliated institutions) are expected to build through their participation in this project: This is an important aspect in the evaluation of proposals and should be presented in some detail. What techniques, literature, theories, tools, etc. will the team and their institutions learn (acquire in practice) or deepen their
knowledge of? How will these skills help team members in their career development? Also indicate which specific tasks each team member would carry out in executing the project.

The Faculty of Economics at the Universidad del Rosario has made an ambitious effort to strengthen applied research and outreach. In this context it has developed a number of research projects in the development economics, public economics, and international economics areas, some of which have entailed the use of computable general equilibrium models. Three of these developments had the scientific, technical, and financial support of the PEP network and have contributed to the development of important analytical capabilities and technical skills in our Faculty. Continued work on these research areas is highly valuable for us both for academic and social purposes.

In terms of research capacity building there are several dimensions to which this project will add.

First, it will contribute to cement our expertise in the development and use of computable general equilibrium models for policy analysis; in this particular case extending it to the use of recursive dynamic models.

Second, it will provide Dora Jimenez with a hands-on experience in building and using CGEs, an area in which she has developed limited previous work and we have a common interest in furthering. The activity will enhance Dora’s learning process at the doctoral programme and adds an important dimension to her economics toolkit.

Third, upon completion of her PhD, Dora Jimenez will return to Medellin (one of the biggest Colombian cities) to teach at the National University’s branch there. This is an important feature of the project, since we plan to continue working together on these issues and to build a network using our universities as hubs for further research using these techniques. Development of the planned activities will reflect in broader and deeper teaching and research activities for Dora’s students at the National University and for our students at El Rosario.

Fourth, the project will provide Edwin Torres with an excellent opportunity to enhance his research at our Faculty; in particular for developing skills in data management and analysis, as well as in the use of national accounts data and in the construction of SAMs, besides getting exposed to the basics of general equilibrium modeling.

Providing our master students and students in the young researchers’ programme, which is Edwin’s case, with an enabling environment is one of our Faculty’s goals. Given Edwin's interest in international economics and applied general equilibrium modeling, this research, with the support of PEP, would be a valuable opportunity for him.
Fifth, the project will provide Mónica Gasca her first in-depth research experience. Mónica has been research assistant in topics related to agricultural investment, but has no previous experience in data management and processing of household and manufacturing surveys. The project will provide her such an opportunity, besides acquitting her with the dynamics of building a SAM. This research experience will be a great avenue for her to transition from her undergraduate program to the master program.

Lastly, as mentioned, we are in the process of establishing an Observatory on International Economics, to which around eight undergraduate students are linked. It is our plan to involve them in this project in a limited fashion, through the development of a course on the structure of the Colombian economy, comprising a primer on input-output models and general equilibrium modeling. The work we will do for building the SAM will provide the basic material for the class and we will seek to cultivate these students interest in the topic we will be working on and in CGE modeling.

<table>
<thead>
<tr>
<th>Name</th>
<th>Task</th>
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<tbody>
<tr>
<td>Ricardo Argüello</td>
<td>Adapting the model to be used, general coordination of the project, providing guidance to the other team members, keeping track of coordination and discussion with people identified in the Policy influence plan. Analysis and discussion of results and preparation of reports.</td>
</tr>
<tr>
<td>Dora Jiménez</td>
<td>Assisting in adapting the model to be used, responsible for building the SAM needed, and providing support for data collection and processing. Analysis and discussion of results and preparation of reports.</td>
</tr>
<tr>
<td>Edwin Torres</td>
<td>Responsible for data processing and analysis needed for building the SAM, assisting the building of the SAM, and calculating parameters needed for the model. Analysis and discussion of results and preparation of reports.</td>
</tr>
<tr>
<td>Mónica Gasca</td>
<td>Assisting in data gathering and processing and helping build the SAM. She will be directly linked to the processing of household and manufacturing surveys in the context of building up the SAM. Besides, she will act as the teaching assistant for the course on the Colombian economy that will be offered to the group of students linked to the Observatory on International Economics.</td>
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8. **List of past, current or pending projects in related areas involving team members**
<table>
<thead>
<tr>
<th>Name of funding institution</th>
<th>Title of project</th>
<th>Team members involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEP</td>
<td>Poverty Impacts of Agricultural Policy Adjustments in an Opening Economy: The Case of Colombia</td>
<td>Ricardo Argüello</td>
</tr>
<tr>
<td>PEP-IFPRI</td>
<td>The International Economic Crisis and the Colombian Economy</td>
<td>Ricardo Argüello</td>
</tr>
<tr>
<td>PEP</td>
<td>Fiscal Policies and Increased Trade Openness: Poverty Impacts in Ecuador</td>
<td>Ricardo Argüello</td>
</tr>
<tr>
<td>Foundation for Research and Innovation Promotion, Colombian Central Bank</td>
<td>Sectoral Export Market Dynamics in Colombia: Trade Margins and the Economic Cycle</td>
<td>Ricardo Argüello</td>
</tr>
<tr>
<td>National University’s Research Directorate</td>
<td>FDI and productivity spillovers on Colombian manufacturing</td>
<td>Dora Jimenez</td>
</tr>
<tr>
<td>Universidad de Antioquia</td>
<td>Colombian manufacturing sector’s productivity in the context of the oil and mining boom. Are there symptoms of Dutch disease?</td>
<td>Edwin Torres</td>
</tr>
</tbody>
</table>

9. **Describe any ethical, social, gender or environmental issues or risks that should be noted in relation to your proposed research project.**

There are no ethical, social, gender or environmental issues or risks related to this research that we are aware of.

**References**


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