The Regional Economic Impacts of Mining: The Case of Northern Sweden[1]

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ABSTRACT

The commodity boom during recent years has increased mineral prospecting activities considerably, not the least in Sweden. Several new mining projects are in the planning-stage, particularly in the northern parts where communities have been struggling with relatively high unemployment and declining populations during the last decades. New mining projects are therefore greeted with open arms by many of these communities, since such projects can offer plenty of employment opportunities and relatively attractive wages. It is crucial that local planners understand what effects the mining projects will generate to properly prepare themselves and their communities, but predicting the future is no easy task. Nevertheless, in the paper at hand we use a regional economic-and demographic model of the Swedish economy to estimate the potential socio-economic impacts of two new iron ore mines in Pajala, a small municipality in the northern-most parts of Sweden, where unemployment and demographic decline have been particularly troublesome. Our analysis considers the potential for mining to contribute to local employment, incomes and not the least demographic growth.

Additional Key Words: impact assessment, mining employment

INTRODUCTION

The commodity price boom that emerged around 2004 has fuelled a renewed interest in mineral exploration, not the least in northern Sweden. The Geological Survey of Sweden (2008) reports that world mineral exploration costs (excluding energy minerals) increased by some 40 percent during 2007 compared to the previous year and amounted to a total of approximately US$10.5 billion. In Sweden, the relative increase was even greater at 70 percent compared to 2006. Some of these efforts may eventually result in the emergence of new mines, or re-opening of old mines where operations ceased at a time when demand was not sufficient to maintain profitable production. Since a lot of the exploration efforts in Sweden are located in the northern, rural parts were unemployment tends to be quite problematic—at least by Swedish standards, the prospect of new mines which may provide large-scale employment opportunities at relatively attractive wages are often welcomed with open arms by the locals as well as the authorities.

Such is the case in Pajala—a small town in the sparsely populated Torneå Valley area in the eastern parts of Norrbotten County, where a new mining project is currently being developed by the Canadian company Northland Resources Inc. The company intends to establish at least two major iron ore mines (Tapuli and Stora Sahavaara) in Pajala

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municipality and tentatively estimate that slightly over a thousand workers will be employed in its Pajala-operations.

The socio-economic impacts of the new mines in Pajala may be quite profound, as the municipality has been struggling with a constantly decreasing population—they've lost nearly 50 percent of the population since the late 1960s—and relatively high unemployment. The fact that the total population in working ages was only 3200 at the start of 2008 indicates the magnitude of the demand shock that will occur on the local labour market when the new mining projects will require over a thousand workers. The municipal government expects that the population will increase substantially and thus reverse the dreary development and provide a welcome injection of tax revenues to the municipal budget.

There are a number of international examples of how new mining projects have contributed to the development of local communities, where the most obvious benefits include job-creation and increased incomes. McMahon and Remy (2001) emphasize that indirect employment effects are often extremely important, concluding that non-mining related employment generated through so-called *multiplier effects* is often much higher than the direct employment created by new mines, even when including mining-related employment in sub-contractors and suppliers. Additional local benefits generated by new mining projects typically include investments in transport infrastructure and expanded power generation- and/or transmission capacity which are beneficial for the whole region.

So, mining can have considerable positive local economic impacts, but the results from economic analyses indicate that the magnitude of the impacts seem quite different from mine to mine. Case-studies on selected mines in Latin America (e.g Pasco-Font et al. 2001, Castillo et al. 2001) have estimated the indirect regional effects of mining on total employment ranging from approximately a 1:1 ratio between new jobs in mining and jobs created elsewhere, to a ratio of nearly 6 jobs created elsewhere per job in mining. Several factors may influence the estimated socio-economic effects from a particular mine, but some of the principal include; (i) the location of the mine, (ii) the scale of operations, and (iii) the methodology and geographical scope of the economic analysis.

Regional economic impact analyses are typically conducted using so-called input-output techniques (see for ex. Aroca, 2001) which attempt to quantify the *backward* and *forward linkages* between different sectors in an economy to trace the effect of increased (or in some cases, decreased) economic activity in one sector and assess its total effect on all other sectors in the economy. This approach typically separates between *direct* effects, comprising increased incomes, output and employment in the sector under scrutiny, and *indirect,* or *multiplier* effects, which embody the effects of changes in demand for various goods and services caused by the initial change in economic activity in one sector. The results from such analyses can therefore be useful tools to illustrate the importance of certain economic activities, as they not only explicitly identify the magnitude with which an activity contributes directly, but perhaps more importantly provides an assessment of how sensitive the rest of the regional economy is to changes in that particular activity.

The purpose of the paper at hand is to summarize and discuss the main results from a more extensive report (Ejdemo and Söderholm, 2008) commissioned by Northland Resources Inc. where we conducted a tentative impact assessment of the Pajala mining projects, using long-term scenario analysis. The report in question provides several alternative scenarios for the future and an extensive discussion of their implications, but this paper will for practical reasons be limited to only addressing the main results reached in the impact assessment and briefly comment on some of the most significant implications.

Methodologically, our approach utilizes the regional economic- and demographic model rAps built around an input-output core which is used extensively by various authorities and public planners in Sweden. This modelling tool extends the traditional input-output analysis

by several measures, not the least by including a representation of the regional linkages between demographic development, labour market and industrial production. It also enables us to project long-term scenarios from present day to 2025 and evaluate the effects of different assumptions regarding the future development. Thus, our approach in many ways resemble studies which utilize the so-called computable general equilibrium (CGE) models, which economists use extensively for scenario-analysis regarding for example economic policy measures, but CGE models typically contain more sophisticated representations of economic linkages than our input-output core. CGE-models may thus offer some advantages over input-output techniques, but existing CGE-models are typically designed for national and international settings, whilst we are interested in modelling economic impact scenarios in a quite narrow geographic scope. At present, the rAps-model probably provides the best available tool for such analyses in Sweden. However, a limitation of the present version of the model is that it lacks the ability to model cross-border activities between Sweden and Finland. As Pajala is located near the border to Finland, the scope of our study is therefore limited to analysing effects on the Swedish side of the border, and possibilities such as cross-border commuting are not considered explicitly.

The remainder of the paper is structured in the following manner. Section 2 reviews the methodology in more detail and describes the regional economic- and demographic model without going into technical detail (as the specification is proprietary). We discuss the underlying assumptions for the model simulations and present the input-data for the modelling procedures which have been supplied by Northland Resources Inc. Section 3 presents the results of the simulations and we address some implications regarding these. Some concluding remarks are given in section 4.

METHODOLOGY AND MODEL

The regional rAps-model, which was developed by Nutek – the Swedish agency for economic and regional growth, combines an economic and demographic model built around an input-output core and is intended mainly for regional impact analysis, long term projections and policy analysis. In this study, we use the model to project a long-term regional economic scenario assuming business-as-usual for the municipality of Pajala from present day up to 2025 with respect to population development, employment and incomes. This constitutes our *baseline scenario* against which several alternate scenarios can be evaluated to test the effects of different assumptions, in our case we include the new mining projects and some of the related investments to assess how this impacts on the development we projected in the baseline.

Since a number of unknown factors may impact the regional development to some extent, we stress that the baseline scenario projected here should be interpreted with caution, as it represents only one of many possible future outcomes and is by no means intended as a thorough forecast of the actual development. The scenario does however provide us with a useful measuring stick against which we can assess the local effects of a demand-shock such as the new mining projects.

The model comprises five different modules which together mathematically represents a regional economy, in our case specified to represent the municipality of Pajala. The model is linked to a detailed regional proprietary database maintained by Statistics Sweden (SCB) and operates through a demand driven iterative process between the five modules.

A schematic overview of the model is presented in figure 1, where the calculations for our baseline scenario assuming business-as-usual in the municipality of Pajala proceeds as follows. Block 1—*population*—calculates a baseline population projection for Pajala up to 2025. This provides input data for block 2—*Labour market*—where a preliminary estimate of the size of the labour force is calculated.

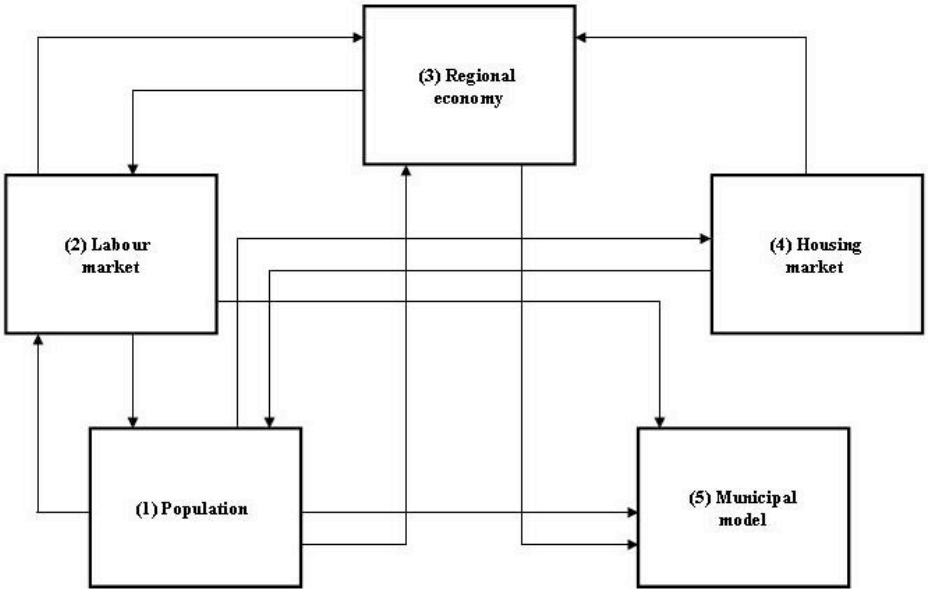

Figure 1. Schematic overview of the rAps-model
Source: Statistics Sweden

Module 3 calculates gross production, incomes and demand for labour. Initially, a preliminary estimate is calculated for the 49 sectors represented in the model. Block 4 considers the housing market with respect to the population projection from module 1.

The model then performs several iterations between blocks 2 and 3 to balance the labour market against the regional economy, solving for the condition that the number of people in the labour force plus net commuting corresponds to the number of employed plus unemployed. Finally, block 5 breaks down the results in further detail and calculates the municipal incomes and expenditures based on current taxes and government grants.

Making long-term projections such as these requires that one makes several assumptions regarding the future upon which the model simulations then build. In the baseline scenario, we assume that the local demographic development will conform to the historic trend, which has been in a constant state of decline for several decades. The population is slowly but surely growing older and there is little reason to assume a different development in a state of business-as-usual. Macroeconomic forecasts on factors such as growth of production and employment were gathered from long-term projections made by the Ministry of Finance (SOU 2004:19) and constitute the basis for the economic development in the baseline scenario.

We then use the model to simulate the local development during the same time-period (present to 2025) when the new mining projects in Pajala are introduced. We use input data supplied by Northland Resources Inc. regarding annual production, employment and capital costs for investments at each site (Tapuli and Stora Sahavaara) to simulate the impacts these factors make on the local economy of Pajala, relative to the projected baseline scenario. Tables 1 and 2 presents these input data, which should be considered as estimates as they contain a considerable amount of forecasts, not the least regarding future commodity prices. It should be noted that mine closure is assumed to take place before 2024, but this is a rather restrictive estimate based on so-called NI43-101 compliant resources, and may be extended considerably.

Table 1. Input data including processing plants and Stora Sahavaara pellet plant

Year	Tapuli Total workforce	Gross production at market value (MSEK	Stora Sahavaara Total workforce	Gross production at market value (MSEK)
2009	112	311	0	0
2010	205	640	0	0
2011	205	954	0	0
2012	371	1479	411	954
2013	371	1396	700	4316
2014	371	1431	700	4383
2015	371	1443	700	4656
2016	371	1572	700	4906
2017	371	1507	700	4893
2018	371	913	700	4973
2019	0	91	700	4998
2020	0	91	700	4977
2021	0	91	700	5246
2022	0	91	700	5421
2023	0	91	700	2261

Several large investments are necessary to commence production at the sites. However, many of these investments include various machinery and equipment which will not be purchased locally. The investments that are anticipated to generate local employment are assumed to be *buildings, site civils* and *concrete structures.*

Table 2. Assumed investments

	Capital costs (MSEK)			
	2009	2010	2011	2012
Buildings	56	56	56	56
Concrete structures	26	26	26	26
Site civils	14.4	14.4		

In the simulated *mining* scenario, we assume that the mining projects will cause a surge in demand on the local labour market, which is met by a certain level of migration to Pajala. This notion lends support from, among others, Westerlund (1998), who confirms that Swedish regional labour market conditions indeed affect aggregate long-distance migration in accordance with economic theory. Due to the relatively small supply of local labour, a considerable amount of in-migration is expected. In our simulations, we allowed the population to increase to the extent that the labour market participation rate did not drop below the rate of the base-year, which was 69 %, and the rate should not be declining over the projects life-time. We study the effects in three basic phases of the projects; (i) the construction phase, (ii) the production phase and (iii) the eventual closure, which is assumed to take place after 2018 for Tapuli and 2023 for Stora Sahavaara, in accordance with the proposed mining schedule.

RESULTS

Figure 2 illustrates the projected population development and compares the baseline scenario against our *mining* scenario. The reference case conforms to the historic trend of decreasing population, but our simulation results indicate that the mining projects have the potential to increase the population by a considerable amount, thus reversing the dreary development which the small municipality has been forced to face for several decades. Our calculations suggest that the population in Pajala could potentially—given that labour market participation

rates are allowed to increase slightly—increase to an average of 9077 persons during the maximum production phase (2013-2017), compared to the projected baseline population of 5655 during the same period.

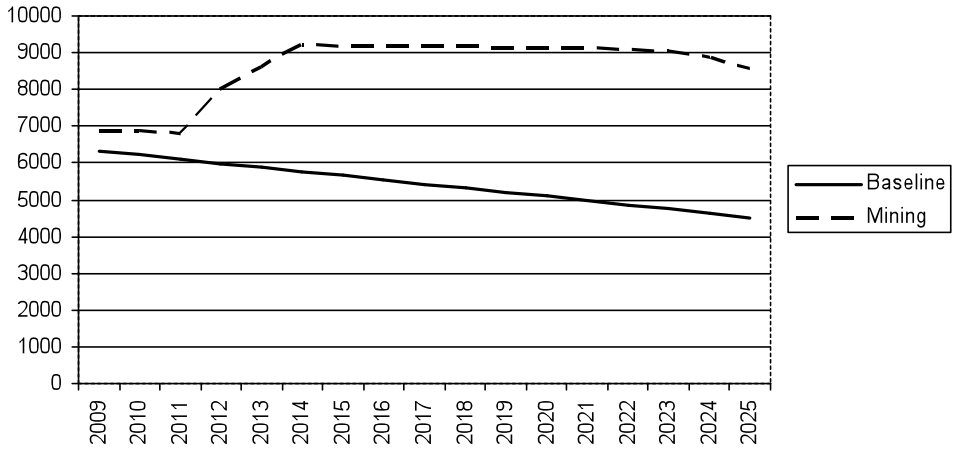

Figure 2. Population development in the baseline and mining scenarios

In reality, demand for labour could be met through long-distance commuters, something that would cause leakages of earnings and spending from the local economy. However, given the long distances, the small populations in neighbouring municipalities, and the relatively poor level of infrastructure necessary for viable long-distance commuting, most workers will at least have to have some kind of living arrangement in Pajala and perhaps commute on a weekly basis. This necessitates that we include such workers as members of the municipal population in the model simulations, as they will certainly contribute to the local economy through income spending and thus increase the demand for local goods and services. Furthermore, the results are of course sensitive to demographic assumptions. An alternative model run which allowed the population to reach 10819 during the maximum production phase was rejected as it resulted in a labour market participation rate of 67 % which is considerably lower than in the base year. Similarly, restricting the population increase so that it reached 7586 during the maximum production phase resulted in higher labour market participation rates than our main *mining* scenario, but caused commuting, which is not explicitly considered in this paper, to reach unsustainably high levels given the long distances and relatively poor infrastructure in the region.

The predicted total employment in Pajala in the *baseline* and *mining* scenarios is illustrated in figure 3. The figure indicates a steep decline in 2019 when Tapuli ceases operations and the employment decreases towards the baseline in 2024 following the scheduled closure of Stora Sahavaara.

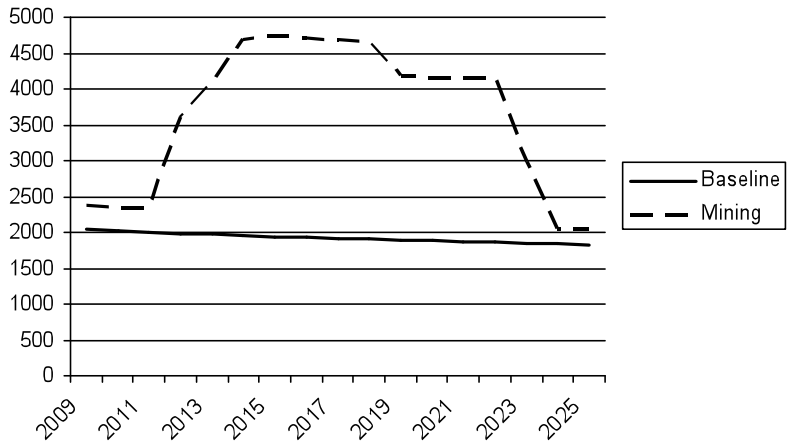

Figure 3. Total employment in the baseline and mining scenarios

The course of events depicted during the later years in figure 3, which may leave some readers with a bitter aftertaste, may well be an exaggeratedly pessimistic image of the future. The reasons for this are twofold; *(i)* the scheduled mine-life is based on so-called NI43-101 compliant resource estimates, which are restrictive by nature and may well be expanded, thus increasing the mine-life, and *(ii)* one can hardly claim that economic impact modelling is an all-seeing 'crystal ball'. In our model, mine-closure simply causes the model to revert back towards the baseline, with slightly higher employment due to the larger population, whereas in reality other sectors may expand to broaden the economic base in the municipality and alleviate the impacts of mine closure, something that is hard, if not impossible to forecast.

Regarding *direct* and *indirect effects*, our calculations suggest an average employment multiplier of 2.47 during the maximum production phase (2013-2017) indicating that for every 100 jobs in mining, 147 jobs are supported elsewhere in Pajala. Table 3 compares the average total employment predicted in the *mining* scenario against the *baseline* scenario and details the average *direct* mining employment and average *indirect* employment generated during the construction (2009-2012) and max production (2013-2017) phase. Peak employment is predicted at 4724 during 2015, but since there is some inescapable uncertainty involved in predicting the future, we present averages of several years as they represent a more reliable measure.

Table 3. Employment in the baseline and mining scenarios

	Employment		Increase from baseline	Direct mining employment	Indirect employment generated
	Baseline	Mining			
Construction phase	2009	2665	657	326	331
Maximum production phase	1939	4584	2645	1071	1575

Although we do not present it here, our full impact assessment report (Ejdemo and Söderholm, 2008) indicates that the relative indirect effects generated by the Tapuli mine are larger than by Stora Sahavaara. Much of the necessary infrastructure is shared between both facilities in the aggregated scenario and mostly in place at the time Stora Sahavaara commences production, so in a sense, 'the table has already been set'. The total impacts are however considerably larger when both mines are accounted for in the simulations, as Stora Sahavaara provides nearly two times as many direct jobs as Tapuli.

Furthermore, our simulations indicate that the mining projects will cause a shift from public sector employment, where wages tend to be low, towards an industrial base where wages are higher. Intuitively, this suggests that the incomes will also increase considerably. Table 4 summarizes the predicted average disposable (per capita) and municipal incomes during the construction and maximum production phases. It is of course hard to predict future macroeconomic and political developments which may influence incomes so the actual numbers should be interpreted with caution, but the trend is clear; Pajala will certainly become a wealthier community as a result of the new mining projects.

Table 4. Predicted effects on incomes (averages, personal and municipal)

	Disposable income/capita (kSEK)		Municipal income (MSEK)	
	Baseline	Mining	Baseline	Mining
Construction phase	114	131	442	569
Maximum production phase	124	187	442	875

Average disposable income per capita was predicted at 131100 SEK during the construction phase and 186800 SEK during the maximum production phase, with peak disposale income predicted at 192000 during 2017.

The forecasted population increase generates increased demand for public services and a need for expansion and upgrades of local infrastructure. The municipality finances these services mainly through tax revenues and government grants. Naturally, if incomes do indeed increase according to our calculations, the municipal tax revenues will also increase considerably. Our results suggests that municipal income essentially doubles compared to the baseline scenario, thus providing the municipal government with the means to maintain necessary public expenditures and finance investments to provide the requisite public services. The numbers should however be interpreted with caution, as they are subject to a number of unknown factors such as future political developments impacting tax policies and the distribution of government grants.

In summary, we have now briefly reviewed some of our main results from the local economic impact assessment of the Tapuli and Stora Sahavaara iron ore mining projects in Pajala. Our results indicate that, as anticipated, the new mines will have considerable positive impacts on the local economy. However, the simulation-based results presented here are subject to a number of unforeseeable factors and are perhaps best viewed as an indication of the *potential* for local development as a result from the new mining projects. We have assumed that surging demand for labour is met by a large population increase, something that may prove faulty in hindsight as workers may opt to long-distance commute instead of settling down in the municipality, hence causing leakages of earnings and spending and thereby reducing the indirect effects on the local economy. If, and to what extent the local government is able to attract workers to settle down in the municipality is critical, if they wish to maximize the local benefits of the surging demand for labour.

It is quite intuitive that Pajala's economy stands before a shift from public sector dominance towards an industrial base. For the locals, this is a welcome development judging by current media reports, but it also poses several challenges for the local planners as the demand for different types of skilled labour suggests that a large in-migration will take place. Furthermore, the restructuring may induce sectors that are quite small at present to expand considerably. It is crucial that the municipal administration is prepared for these effects, so that they may develop the necessary resources to service the needs of the transformed business sector.

The results from our simulations suggest an employment multiplier of 2.47 during the maximum production phase (2013-2017) indicating that for every 100 jobs in mining, 147

jobs are supported elsewhere in Pajala. This multiplier is within the normal range for similar studies (e.g. World Bank and International Finance Corporation, 2002), albeit on the more optimistic side compared to the few Swedish studies available (See for example Sörensson (2003), who used a similar approach to arrive at an estimated employment multiplier of 1.68 for two goldmines in Västerbotten county). Overall, our results indicate that the non-mining related employment will account for a large share of the total employment in the *mining* scenario. This result corresponds well with McMahon and Remy (2001), who assert that non-mining related employment generated through multiplier effects is often much higher than the mining-related employment, even when including sub-contractors and suppliers.

CONCLUDING REMARKS

We used a regional economic- and demographic model to assess the long-term economic impacts of two new major iron ore mines in the municipality of Pajala. Our calculations, which are perhaps best viewed as an indication of the *potential* for local development, suggest that there is substantial room for growth in the municipality if workers can be convinced to settle down in Pajala with their families. We estimated an average population of 9077 persons during the maximum production phase (2013-2017), compared to the projected baseline population—assuming business-as-usual—of 5655 during the same period.

Some 1071 direct employment opportunities in the mining industry provides a welcome addition of jobs to a municipality where unemployment has been quite problematic—at least by Swedish standards. We attempted to quantify the total effect on employment including indirect effects and arrived at an employment multiplier of 2.47, or an average of 1575 additional jobs sustained elsewhere in Pajala during the maximum production phase, jobs that to a large extent are created in non-mining related sectors. We conclude that the rather large predicted indirect employment effect is driven by the increased demand from a growing population, caused by in-migration of workers and their families who find employment in either the mining industry or other expanding sectors.

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LITERATURE CITED

Aroca, P. 2001. Impacts and development in local economies based on mining: The case of the Chilean II region. Resources Policy 27 (2001) 119-134

Castillo, J. Sánchez, J.M. Kunze, V and Araya, R. 2001. Chile: Size Does Matter. *In*: McMahon, G and Remy, F (2001) Large Mines and the Community – Socioeconomic and Environmental Effects in Latin America, Canada and Spain. World Bank (Washington DC) and International Development Research Centre (Ottawa, ON)

Ejdemo, T and Söderholm, P. 2008. Local Economic Impact Assessment of the Tapuli and Stora Sahavaara Mining Projects. Report on behalf of Raw Materials Group for Northland Resources Inc. September 2008.

Geological Survey of Sweden. 2008. Statistics of the Swedish Mining Industry 2007, Per.publ. 2008:2 Uppsala, Sweden

Pascó-Font, A. Diez Hurtado, A. Damonte, G. Fort, R. and Salas, G. 2001. Peru: Learning by Doing. *In*: McMahon, G and Remy, F (2001) Large Mines and the Community – Socioeconomic and Environmental Effects in Latin America, Canada and Spain. World Bank (Washington DC) and International Development Research Centre (Ottawa, ON)

McMahon, G and Remy, F. 2001. Large Mines and the Community – Socioeconomic and Environmental Effects in Latin America, Canada and Spain. World Bank (Washington DC) and International Development Research Centre (Ottawa, ON)

SOU 2004:19. The Long Term Survey of the Swedish Economy 2003/04. Swedish Government Official Report. Ministry of Finance

Sörensson, R. 2003. Effektstudie av gruvetableringar i Lycksele och Storumans arbetsmarknadsregioner. CERUM Report II: 2003. Umeå Universitet, Umeå

Westerlund, O. 1998. Internal Migration in Sweden: The Effects of Mobility Grants and Regional Labour Market Conditions. Labour 12 (2) 363-388 (1998)

World Bank and International Finance Corporation. 2002. Large Mines and Local Communities: Forging Partnerships, Building Sustainability. Second issue of the Mining and Development Series. World Bank, Washington D.C 2002